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1.0 INTRODUCTION

On August 13, 1993, an Agreed Order between a group of Potentially Responsible Parties (PRPs) and the Indiana Department of Environmental Management (IDEM) became effective upon execution by the Commissioner of IDEM. A copy of the Four County Landfill Site (Site) Agreed Order (Cause No. OER-92) is provided as Appendix A. The PRPs identified by IDEM comprised both de minimis and non-de minimis respondents whom allegedly contributed waste materials to the Site and/or participated in the operation of the landfill. The majority of non-de minimis respondents identified by IDEM joined together to form the Four County Landfill Group (Group).

The substantive requirements of the Agreed Order, inter alia are:

> (a) to determine the nature and extent of the potential threat to the public health, welfare or the environment caused by the release of pollutants or contaminants from the Facility by conducting a Remedial Investigation (RI) consistent with the NCP; (b) to identify and evaluate alternatives for remedial action to prevent, mitigate or otherwise respond to or remedy, as necessary, any release or threatened release of hazardous substances from the Facility by conducting a Feasibility Study (FS) consistent with the NCP; (c) to stabilize and maintain the Facility, as determined by the parties by collection, storage and disposal of leachate generated and surface water collected on-site until 270 days after the approval of the final FS report by IDEM.

In order to ensure compliance with the first two requirements of the Agreed Order, Conestoga-Rovers & Associates (CRA) was retained by the Group to plan and implement the Remedial Investigation/Feasibility Study (RI/FS). In addition, an individual Respondent separately retained Keramida Environmental, Inc. (Keramida) to ensure that the Group's obligations set out under item (c), above are met.

A "Site Background Summary and Detailed Scope of Work" (SOW) prepared by Environmental Resources Management - North

Central, Inc. (ERM), was submitted to IDEM by the Group, in support of a Good Faith Offer to IDEM put forth on April 27, 1992. The SOW presents a summary of existing data previously collected at the Four County Landfill Site, including a compilation and evaluation of available information regarding Site history, Site physical characteristics, waste characteristics, and the nature and extent of contamination. In addition, a scope of work was included for performing Site stabilization activities and a RI/FS. Much of the Site background information contained in the SOW has been incorporated into this RI/FS Work Plan. Moreover, the SOW, in accordance with the Agreed Order, sets out the basis for the work to be undertaken during the RI/FS.

The RI/FS Work Plan presented herein has been prepared in accordance with Sections 38 and 39 of the Agreed Order, the SOW (Exhibit II of the Agreed Order), Section 121 of CERCLA and U. S. Environmental Protection Agency (USEPA) guidance documents for conducting an RI/FS.

This RI/FS Work Plan presented herein is organized into the following sections:

i) Section 1.0 presents the purpose and objectives of the RI/FS as well as the organization of the RI/FS Work Plan;

ii) Section 2.0 discusses the Site location and presents a chronological history of Site activities compiled from various background documents;

iii) Section 3.0 outlines the physical characteristics of the Site including surface features, geology, hydrogeology, soils, climate, land use and ecology;

iv) Section 4.0 provides a source characterization summary including the history of disposal and containment and identification of wastes;

v) Section 5.0 discusses the nature and extent of contamination in groundwater, soil, sediment, surface water, air and ecology;

vi) Section 6.0 identifies potential applicable or relevant and appropriate requirements (ARARs) identified for the Site;

vii) Section 7.0 details the RI activities to be conducted;

viii) Section 8.0 presents the Sampling and Analysis Plan (SAP) including a Field Sampling and Analysis Plan (FSAP) and a Quality Assurance Project Plan (QAPP) for the RI/FS activities;

ix) Section 9.0 discusses the FS Work Plan;

x) Section 10.0 identifies the Health and Safety Plan to be implemented during RI/FS activities;

xi) Section 11.0 details the permitting plan;

xii) Section 12.0 discusses reporting requirements and RI/FS deliverables;

xiii) Section 13.0 presents the project organization and schedule for implementation;

xiv) Section 14.0 provides the Site operation and maintenance plan; and

xv) Section 15.0 outlines community relations activities to be conducted.

2.0 SITE LOCATION AND HISTORY

2.1 LOCATION

The Site is located in Aubbeenaubbee Township, in north-central Indiana, in the southern half of the southwest quarter of Section 16, Range 1 East, Township 31 North (Figure 2.1). The Site is located approximately 3.5 miles southeast of the common corner of Fulton, Marshall, Starke, and Pulaski counties, near the intersection of State Highway 17 and County Highway 525 North. The nearest towns are Delong, located approximately 1 mile to the northeast, and Leiters Ford, located approximately 2 miles to the east-southeast. The Site is approximately 6 miles south of Culver and 15 miles northwest of Rochester.

The Site occupies approximately 61.5 acres, including the County and State highway rights-of-way. State Highway 17 divides the property into an eastern and western parcel. Land disposal activities were formerly conducted on approximately 30 acres of the western parcel, which has been the focus of investigative activities conducted at the Site. The western parcel (i.e., the Four County Landfill Site) is bounded on the east by State Highway 17, on the north by County Highway 525 North, on the west by a county road right-of-way, and on the south by wooded land. Permanent Site features have been surveyed and a 100-foot Site grid has been established (Figure 2.2). For ease in identifying specific features, the western parcel has been further divided into four geographic quadrants (i.e., the southeast, southwest, northwest, and northeast quadrants), which have been arbitrarily defined by the 7+00 North and 8+00 East survey grid lines.

2.2 SITE HISTORY

The following subsections present a chronology of the Site history as it relates to ownership, general operations, regulatory actions, and investigative activities. More detailed information regarding the chronology

of waste disposal is contained in Section 4.0. Historical information was obtained primarily from the following documents:

- "Hazardous Waste Ground-Water Task Force Evaluation of the Four County Landfill, Fulton County, IN," prepared by USEPA Region V and IDEM. Document Number: EPA-700 8-87-013, dated May 1987.

- "Comprehensive Monitoring Evaluation" (CME), prepared by Jacobs Engineering Group Inc. (Jacobs) in Lakewood, Colorado, for USEPA Region V. Final, dated January 27, 1988.

- "Corrective Action Plan (CAP) Task I - Description of Current Conditions," submitted by Environmental Waste Control, Inc. (EWC) and prepared by Geosciences Research Associates, Inc. (GRA) in Bloomington, Indiana. Final, dated December 7, 1989.

- "Four County Landfill Fact Sheet," ("Fact Sheet", 1990) prepared by Katten, Muchin & Zavis, Special Environmental Counsel for the bankruptcy estate, based on interviews with Mr. Stephen Shambaugh and Mr. James Wilkins of EWC. Document number: 00150573, dated October 12, 1990.

A listing of the substantive documents prepared as part of previous Site investigations and regulatory activities is provided in Table 2.1. These documents were used to confirm the background information presented in this Site background summary.

1972 to 1977

Prior to 1972, no landfilling or dumping operations were conducted on the property, which consisted of farmland. A document entitled "Engineering Report - Proposed Commercial Sanitary Landfill Project" was prepared by Mr. Joseph L. Tite on June 21, 1972. The report included a proposed Site plan and soil boring logs for approximately six to

eight borings that were advanced in both the western and eastern parcels. In July 1972, Mr. Avery Wilkins received approval from the Indiana State Board of Health (ISBH) and the Fulton County Commissioners to use the property as a sanitary landfill (GRA, CAP Task I, 1989). Operations began in August 1972, and in accordance with a permit from the ISBH, the Site accepted primarily municipal waste. In addition, some liquids were accepted after 1972 (Jacobs, 1988). During this period of time, cut and fill and area fill landfilling operations were conducted. Unlined waste deposits were covered with backfill ("Fact Sheet", 1990). On March 13, 1973, the ISBH sent Mr. Avery Wilkins a Notice to Cease and Desist regarding the dumping of barrels of waste solvent. The facility was also ordered to comply with ISBH's compaction and cover regulations.

1978 to 1981

On June 22, 1978, Mr. Stephen Shambaugh and Mr. Doug Johnson (as major shareholders) formed EWC to operate the Four County Landfill Site (GRA, CAP Task I, 1989 and "Fact Sheet", 1990). In September 1978, the ownership of the property containing the present landfill was transferred to Mr. James Wilkins (the son of Mr. Avery Wilkins). The landfill construction and operating permits were transferred from Mr. Avery Wilkins to EWC in October 1978 (GRA, CAP Task I, 1989).

The groundwater at the Site was originally evaluated between December 1978 and February 1979 to determine whether the landfill could be permitted to accept "separate area waste", the ISBH's general definition for commercial and industrial waste prior to promulgation of RCRA (USEPA, 1987 and "Fact Sheet", 1990). Monitoring wells MW-1 to MW-7 were installed by water well contractors in a surficial, glacial till, and at least one of these wells was located in each of the Site quadrants shown on Figure 2.2.

From November 1978 to November 1980, the Site was approved by the ISBH to handle separate area waste that included plating sludge, municipal wastewater treatment sludge, asbestos (brake dust

grindings), and liquid (including hydroxides and dewatered sludges). These materials were reportedly placed in unlined cells ("Fact Sheet", 1990). On August 18, 1980, EWC notified the EPA that it was disposing of hazardous wastes at the Landfill. Moreover, according to IDEM: *On November 18, 1980, as required by law, EWC submitted Part A of an application for authorization to treat, store or dispose of hazardous waste at the Landfill. Under RCRA, EWC was then accorded "interim status" pending final administrative disposition of its permit application, allowing it to operate its facility.*[1]

1982 to 1984

In 1982, EWC received letters from the ISBH stating that the existing groundwater monitoring system was inadequate (Jacobs, 1988 and "Fact Sheet", 1990). Mr. James M. King, a consulting hydrogeologist, completed additional soil borings to a maximum depth of 80 feet in 1982. In May 1983, Salisbury Engineering in Griffith, Indiana, a division of ATEC Associates, Inc. (ATEC), installed three additional monitoring wells through the surficial till and into an unconfined aquifer comprised of silty sand (GRA, CAP Task I, 1989). ATEC reported their results in a June 23, 1983 report entitled "Ground Water Study and Monitoring Well Installation". In October 1984, EWC notified the USEPA of statistical differences in groundwater indicator parameters, particularly total organic carbon (TOC), and the need to further evaluate the groundwater at the Site. In addition, ATEC submitted the "Program Proposal - Ground Water Quality Assessment Plan" on November 1, 1984, in response to a formal complaint by the ISBH (GRA, CAP Task I, 1989).

Interim status facilities were required to file a Part B application and certify compliance with all applicable groundwater monitoring requirements and financial responsibility requirements by November 8, 1985[2]. EWC filed the first Part B Permit Application on

[1]Reference: Comment No. 1 in IDEM letter dated December 7, 1993 from Krista E. Duncan of IDEM to Steven J. Wanner of CRA.

[2]Reference: Comment No. 2 in IDEM letter dated December 7, 1993 from Krista E. Duncan of IDEM to Steven J. Wanner of CRA.

January 31, 1984, through which it proposed to conduct landfill disposal of low-level, hazardous, industrial waste. *On November 7, 1985, EWC filed the certificate of compliance with applicable interim status groundwater monitoring and financial responsibility requirements, and a Part B application*[3]. Specific wastes listed on the application included emission control dust; wastewater treatment sludges; and wastes containing cadmium, chromium, and lead. The application indicated that EWC would not accept any ignitable, reactive, radioactive, acidic, or explosive wastes, or any wastes containing free liquids. In response to a letter from the USEPA, EWC provided additional information to clarify the deficiencies identified in its original Part B Application (GRA, CAP Task I, 1989).

In 1984, Mr. Stephen Shambaugh bought out Mr. Doug Johnson's interest in EWC and became the sole owner and active operator of the Site ("Fact Sheet", 1990).

1985 to 1988

In accordance with the ATEC Ground Water Quality Assessment Plan, EWC installed three additional monitoring wells in the northeast quadrant of the Site in April 1985. The deepest of these wells was installed in a gravely sand unit to a depth of 122 feet (GRA, CAP Task I, 1989). Relative to the groundwater issues, EWC and the Indiana Environmental Management Board entered into an Agreed Order (Cause No. N-128) in July 1985 that required EWC to prepare a Groundwater Assessment Plan (GWAP) and submit the plan to the State for approval. On August 21, 1985, the first GWAP was submitted by ATEC (GRA, CAP Task I, 1989). IDEM did not approve the GWAP and subsequently notified the USEPA that the Site was not in compliance with groundwater monitoring requirements ("Fact Sheet", 1990). The USEPA sampled surface water and the existing monitoring well network in June 1986 and summarized the results of this investigation in a report (USEPA, 1987). In October 1986, IDEM sent EWC a Notice of Inadequacy in response to the GWAP and requested the submission of a plan

[3]Reference: Comment No. 2 in IDEM letter dated December 7, 1993 from Krista E. Duncan of IDEM to Steven J. Wanner of CRA.

to describe the installation and location of additional wells (GRA, CAP Task I, 1989).

A data summary report (Dames and Moore, 1986) indicated that the GWAP should allow for modifications to the existing groundwater monitoring system to improve the assessment of upgradient groundwater quality at the Site. Dames and Moore then prepared several versions of a "Hydrogeologic Assessment Report" between 1987 and 1988 to describe data associated with the installation of piezometers and additional monitoring wells. Concurrent with the Dames and Moore investigations, Mr. John Bassett of GRA was retained to provide an interpretation of the geologic setting and stratigraphy. Initially, three stratigraphic units were identified at the facility: (1) a surficial till sequence; (2) a glacial outwash deposit; and (3) a second, deeper till. Discontinuous, perched water zones were found in the surficial till sequence; the aquifer was identified as an unconfined, glacial outwash unit and the deeper till unit was interpreted as the base of this aquifer. GRA's detailed findings are included in the final "Hydrogeologic Assessment Report," dated January 12, 1988. This report identified the Site's existing stratigraphic framework.

The construction of a synthetically lined disposal cell (Cell A) at the Site was initiated in the fall of 1985 and completed in August 1986. Cell A, which was constructed in the southeast quadrant, is double lined and has a leachate collection system ("Fact Sheet", 1990). More detailed information regarding the location and construction of waste cells is provided in Section 4.0. According to the 1990 "Fact Sheet", after Cell A was completed, EWC began the construction of an additional double-lined cell (Cell B) and did not dispose of waste on any other portion of the property (i.e., in unlined cells). After the completion of Cell A in August 1986, EWC did not dispose of waste or any other part of the Site ("Fact Sheet", 1990).

In February 1987, the U. S. Department of Justice filed a civil action suit (Cause No. S87-55) against EWC, Mr. Shambaugh, and Mr. James Wilkins in the Federal Court of the Northern District of Indiana ("Fact Sheet", 1990). The Department of Justice alleged that groundwater monitoring requirements had been violated and that EWC had falsely

certified financial assurance and groundwater monitoring compliance documents ("Fact Sheet", 1990). *Furthermore, since failure to satisfy the financial responsibility and groundwater monitoring requirements would result in the termination of EWC's interim status, the United States alleged that EWC was operating illegally*[4]. At this time, EWC operated the landfill and managed several consultants working at the Site, including:

- Mr. Richard Wigh of Regional Services Corporation (RSC) in Columbus, Indiana, who was working on cell construction at the landfill;

- Mr. Michael Johnson of Advanced Waste Management, Inc. (AWM) in Terre Haute, Indiana, who was providing engineering services;

- ATEC, which was working on hydrogeological studies; and

- Dames and Moore, the firm that had been retained to evaluate regulatory compliance information for both the RCRA Part B Permit Application and the groundwater monitoring program ("Fact Sheet", 1990).

The Site was still in operation and the completed Cell B was being filled while Cell C, also double lined, was under construction ("Fact Sheet", 1990).

On June 30, 1987, EWC submitted a revised RCRA Part B Permit Application to IDEM that included three bound volumes of text and 13 plan sheets. IDEM and USEPA Region V subsequently issued a document entitled "Fact Sheet - Intent to Deny a RCRA Operating Permit" and began a period of public comment on September 30, 1987. On January 18, 1988, EWC submitted a Part B Comments and Supplemental Information package to IDEM that consisted of seven bound volumes of text, including a position letter from EWC's attorney, Mr. George Pendygraft of Baker & Daniels, and

[4]Reference: Comment No. 3 in IDEM letter dated December 7, 1993 from Krista E. Duncan of IDEM to Steven J. Wanner of CRA

detailed responses to IDEM's "Fact Sheet". Following the public comment period, a Notice of Decision was issued by IDEM on June 30, 1988, stating that a final decision to deny the RCRA Part B Permit Application was appropriate (GRA, CAP Task I, 1989).

On January 27, 1988, Jacobs submitted its CME to USEPA Region V as an evaluation of the design and construction of the groundwater monitoring system and the facility's ability to collect and analyze groundwater samples. As a result of the inspection/evaluation, several RCRA violations and method deficiencies were identified (Jacobs, 1988). EWC submitted a proposed RCRA Interim Status "Groundwater Monitoring Plan" (Plan) to IDEM on June 2, 1988. The Plan proposed: (1) the construction of more than 70 new or replacement monitoring wells and piezometers to be installed as clusters at multiple depths within the A, B, and C stratigraphic units defined in the GRA and Dames and Moore reports; and (2) a detailed sampling and laboratory characterization of soil materials (GRA, CAP Task I, 1989). Although some of the monitoring wells proposed in this Plan were designed to replace existing wells that were constructed inappropriately (e.g., with long filter packs and glued joints), no information regarding well abandonment was presented.

IDEM approved EWC's Plan in July 1988, and between November 1988 and December 1989, EWC installed the most recent series of wells and piezometers (GRA, CAP Task I, 1989). In accordance with the Plan, test borings were advanced to bedrock at locations near the four corners of the Site (i.e., to a maximum depth of 217 feet below ground surface), and monitoring wells were installed at variable depths in the aquifer (GRA, CAP Task I, 1989).

The complete results of the 1988 and 1989 investigations are presented in two "Memorandum Reports" prepared by Mr. Bassett of GRA: (1) dated April 28, 1989 and submitted to Mr. Pendygraft; and (2) dated December 15, 1989 and sent to Mr. Shambaugh. These memoranda include soil boring logs, soil analytical data and well/piezometer completion diagrams. As described in these memoranda, solvent odors were detected in a thin, shallow sand seam within the upper till unit at several locations in the

northwest quadrant of the property. Subsequent to the detection of volatile organic compounds (VOC) within the perched water of this unit, EWC installed a groundwater recovery sump (sump P-34A) as an interim corrective measure (see Section 4.3).

On December 5, 1988, the civil suit filed by the U. S. Department of Justice (Cause No. S87-55) went to trial in the U. S. District Court, Northern District of Indiana, South Bend Division with Judge Robert L. Miller, Jr., presiding (GRA, CAP Task I, 1989). West Holding Company, Inc. (WHC), a wholly owned subsidiary of EWC, was formed in 1988 to hold the real estate for the Site and reportedly to simplify the business arrangement between Mr. James Wilkins and Mr. Shambaugh ("Fact Sheet", 1990). WHC was also named as a defendant in the civil suit (GRA, CAP Task I, 1989).

1989 to Present

On March 29, 1989, the U. S. District Court ordered a 2.78 million dollar fine against Mr. Shambaugh and Mr. Wilkins jointly and severally. Facility operations were ordered closed immediately, and the U. S. District Court ruled that a RCRA Facility Investigation (RFI) CAP would have to be implemented at the Site ("Fact Sheet", 1990). At the time of the court decision, Cell C had been completed and was in use. Two weeks after the court decision, Mr. Shambaugh, Mr. James Wilkins, EWC, and WHC filed for Chapter 11 bankruptcy ("Fact Sheet", 1990).

In June 1989, GRA began collecting data to fulfill Task I (Description of Current Conditions) of the proposed CAP, under the direction of the USEPA Region V, RCRA Enforcement Branch. The District Court decision was appealed to the 7th Circuit Court of Appeals (GRA, CAP Task I, 1989) and was subsequently affirmed.

On April 12, 1990, RSC submitted a GWAP to IDEM on behalf of EWC. This GWAP was approved by IDEM on October 10, 1990, with extensive attached modifications, to fulfill the requirements of the original

July 1985 Agreed Order. Pursuant to the March 1989 Judicial Decree for a CAP, EWC submitted several progress reports, including groundwater and sump sampling results, to the USEPA Region V, RCRA Enforcement Branch, between April 1990 and July 1991. Several CAP project plans were prepared by WW Engineering & Science in Grand Rapids, Michigan and Bloomington, Indiana (formerly GRA). These documents consisted of an RFI Work Plan (Task II of the CAP) and a January 31, 1990 corrective measures study (Task VI of the CAP). The Work Plan was approved with modifications by USEPA Region V, RCRA Enforcement Branch in January 1991, and a final version reflecting these modifications was submitted by WW Engineering & Science on March 11, 1991.

According to a June 13, 1991 progress report from EWC to USEPA Region V, WW Engineering & Science notified EWC that it would not continue its involvement in the project because of EWC's financial insecurities. In December 1991, IDEM began a unilateral removal action to stabilize the facility, including the collection, storage, and disposal of leachate and erosion control measures (IDEM Draft Statement of Work, February 1992). OHM Remediation Services Corporation began these Site maintenance activities under the direction of IDEM.

In January 1992, IDEM notified certain persons that it had identified potentially responsible parties and requested that they make good faith offer to conduct Site maintenance activities and an RI/FS study for the Site. After several meetings between the PRP Group and IDEM and pursuant to a requested extension, a group of PRPs submitted a good faith offer by June 1, 1992. IDEM provided comments on the proposed SOW, to which the PRPs subsequently responded. Upon completion of negotiations for terms of an Agreed Administrative Order on Consent (AOC) and finalization of the SOW, (Exhibit II to the AOC) signature pages were submitted to IDEM on behalf of the Four County Landfill PRPs on May 7, 1993, pursuant to the schedule specified by IDEM. The list of the PRPs submitting this good faith offer is included as Appendix B.

On August 13, 1993, IDEM concurred and executed the AOC. Pursuant to its terms, the AOC became effective upon signature. Site

maintenance activities began, as specified in the AOC, on August 29, 1993. This RI/FS work plan is required to be submitted within 60 days of said effective date.

3.0 SITE PHYSICAL CHARACTERISTICS

The physical characteristics of the Site and surrounding area, as described in this section, were garnered from available information concerning regional and Site-specific surficial features, surface water, geology, soils, hydrogeology, climate, land use and ecology. This information will be used during the completion of the RI/FS to assist in identifying and characterizing transport pathways and receptor populations and providing ancillary data for the development and screening of remedial action alternatives.

3.1 SURFACE FEATURES

In 1988, the USEPA's Environmental Photographic Interpretation Center (a branch of the Advanced Monitoring Systems Division of the Environmental Monitoring Systems Laboratory) performed a review of historical aerial photographs of the Site and surrounding properties. This review was conducted at the request of the Environmental Monitoring Branch of USEPA Region V and the Office of Waste Programs Enforcement - RCRA Enforcement Division. Historical black-and-white photographs from 1951, 1957, 1958, 1963, 1971, 1978, 1980, and 1986; color photographs from 1987; color, infrared photographs from 1981; topographic maps; and miscellaneous other information obtained from USEPA Region V were evaluated during the review. The findings of the review, entitled "Site Analysis - Four County Landfill" (April 1988), assisted in the preparation of this subsection and Section 4.0, which describes source characterization.

3.1.1 Regional

The regional surface feature information included in this subsection was obtained primarily from the "Geologic Setting of the Four County Landfill, Fulton County, Indiana" report dated June 5, 1987, prepared by GRA.

The Site is situated in a rural, sparsely populated area consisting of a mixture of agricultural land and woodlands. The area is included in the Steuben Morainal Lake Area (Wayne, 1956) of the Northern Lake and Morainal Region physiographic unit (Malott, 1922). The general area is underlain by approximately 200 feet of Late Wisconsinan drift consisting of till, outwash sand and gravel, fine-textured lacustrine materials, ice-contact stratified drift, and dune sand. Upland areas generally exhibit a hummocky topography with numerous marshy depressions and steep-walled troughs that are characteristic of ice-disintegration features. Ice-contact stratified drift features, consisting of sand and gravel in the form of circular kame deposits, are common. Numerous marshy areas underlain by peat and marl occur in kettle holes formed by the melting of Late Wisconsinan glacial ice. Natural elevations in the immediate areas surrounding the Site range from about 730 to 795 feet above mean sea level (amsl).

3.1.2 Site Specific

The landfilled area consists of double-lined cells that dominate the southeast quadrant and unlined waste deposits in the northwest and southwest quadrants. Although a 15 to 20 foot high ridge originally crossed the property from the northwest to the southeast, this feature was modified by the landfilling activities (Jacobs, 1988). The topography is currently representative of filled areas and cell excavations, with elevations ranging between approximately 760 to 800 feet amsl. In general, the upper surface slopes away in all directions from the south-central region of the Site. An area topographic map is provided as Figure 3.1.

An office, a water supply well, a laboratory, and a wheel/truck wash (i.e., former support facilities) were located in the southeast quadrant of the Site. However, after June 1987, the office and laboratory were moved to the eastern parcel of property, which is located to the east of State Highway 17. A new support facility and wheel/truck wash were built in the northwest quadrant.

A Site topographic map prepared by RSC as part of the RCRA Part B Permit Application shows the March 1987 area topography at a 5-foot contour interval. In 1986 and 1987, a new chain-link fence was installed around the perimeter of the property, and warning signs were affixed to the Site fence, as reported in the Closure and Post-Closure Plans submitted in April 1989.

3.2 SURFACE WATER

3.2.1 Regional

As a result of glaciation, the area surrounding the Site contains a number of small swamps, streams, and lakes, including 24 natural lakes within Fulton County (Harrell, 1935). Lake Maxinkuckee is located approximately 5 miles to the north, and Bruce Lake is approximately 5 miles southwest of the Site. King Lake, which covers approximately 18 acres, is located approximately 0.25 mile east of the Site and has a north-flowing outlet to the Tippecanoe River. The Tippecanoe River flows in a generally northwesterly direction and is located approximately 1 mile north of the Site. Prior to landfilling activities, surface drainage from the area was split along the ridge that extended from the northwest to the southeast across the Site. The runoff from the north and east areas drain easterly toward King Lake. The south and west areas drain generally to the west-northwest, eventually joining the northwest-trending ditch that flows into the Tippecanoe River.

According to wetland inventory maps produced by the U. S. Fish and Wildlife Service (USFWS) and the Indiana Department of Natural Resources (IDNR), palustrine (nontidal marsh) forested wetlands with open aquatic beds and emergent vegetation are present around the Site (Jacobs, 1988 and Cowardin et al., 1979). Based on a review of topographic maps of the area, the three major areas receiving runoff from the Site may include: (1) a wetland basin to the north of the Site, (2) forested wetlands and King Lake to the east of the Site, and (3) a series of connected wetlands and an unnamed stream/ditch to the south and west of the Site.

The wetland basin to the north also receives surface drainage from small areas northwest of the landfill. According to the RFI CAP Task II Work Plan (WW Engineering & Science, 1991), private dumping has occurred to the north of County Highway 525 North in the vicinity of this basin.

3.2.2 On Site

Surface water runon enters the Site from the wooded southern boundary and is directed through a ditch to an area of natural drainage off the western edge of the Site. Water from this area eventually drains to the unnamed, northwest-trending ditch that flows to the Tippecanoe River. Non-leachate runoff (i.e., runoff that does not come into contact with the active portion of the landfill) is collected in a series of ditches and drainage control ponds, stored in either the southwest retention pond or the northeast drainage control basin, and is ultimately discharged from the northeast drainage control basin in accordance with a National Pollutant Discharge Elimination System (NPDES) Permit. EWC originally obtained the NPDES Permit from IDEM on September 24, 1986. The expiration date, effluent limits, and discharge limits are specified in the permit, which was included as an appendix to the 1987 RCRA Part B Permit Application. This NPDES permit expired on September 21, 1991. A timely renewal application has been submitted but no final action has yet occurred. The terms and conditions stated in the original NPDES permit have remained in effect since expiration. The on-Site discharge point allows water to accumulate in the northeast quadrant, then drain into a culvert (located under County Highway 525 North) that empties into the wetland basin north of the Site.

3.3 GEOLOGY

3.3.1 Regional

The information on regional geology included in this subsection was obtained primarily from the June 5, 1987 "Geologic Setting of the Four County Landfill, Fulton County, Indiana" report by GRA and the January 27, 1988 CME by Jacobs.

The bedrock in the area of the Site in Fulton County is covered by a mantle of unconsolidated glacial deposits. Area bedrock consists of middle Devonian Age carbonate rocks, which are part of the Muscatatuck Group. A bedrock core from a well located approximately 2.5 miles east of the Site is described in Doheny, et al. (1975). At that location, there are 67.1 feet of lithographic to bioclastic limestone and fine-grained to saccharoidal dolomite belonging to the Devonian Age Traverse and Detroit River Formations. These Devonian formations overlie 11.9 feet of vuggy Silurian dolomite, assigned to the Salina Formation, which, in turn, overlies 173.7 feet of fine-grained Silurian dolomite assigned to the Wabash Formation. A similar sequence of thick limestone and dolomite bedrock would be expected beneath the Site. A structure contour map of the top of the Detroit River Formation (Devonian) prepared by Doheny, et al. (1975) suggests that the bedrock units dip gently to the north or northeast at about 10 feet per mile, away from the Kankakee Arch and toward the Michigan Basin structural feature.

The bedrock in Fulton County is unconformably overlain by glacial deposits that range in thickness from 100 feet to more than 250 feet (Gray, 1982). Regionally, northwestern Fulton County is located between areas known to have been covered by the southwesterly portion of the Michigan Lobe ice and the southeasterly portion of the Huron-Erie Lobe ice. The resultant, complex stratigraphy is typical of interlobate glaciated areas. Wisconsinan Age glacial deposits in Indiana include ground moraine deposits, end moraine deposits, and ice-contact stratified drift of the Trafalgar, Lagro, and Atherton Formations (Schneider and Keller, 1970). The ground moraine is relatively flat lying and consists of till or unsorted gravel, sand, silt, and clay that was deposited by advancing and retreating glaciers. End

moraine sediments, comprised primarily of till with smaller areas of stratified sand and gravel, were deposited as ridges. These ridges mark the maximum extent of the ice or a pause in glacial retreat. The Maxinkuckee end moraine forms a prominent ridge in western Fulton County. Smaller areas of Wisconsinan Age, ice-contact stratified sand and gravel, which were deposited by running water at the margins of the ice, also occur throughout the region (Schneider and Johnson, 1967).

Additional glacial deposits include valley train and outwash sand and gravel, dune sands, and lake sediments of the Atherton Formation. Sand and gravel were deposited by meltwater streams that flowed from the margins of the glacier and meandered back and forth creating outwash plains. As the ice continued to recede, wind reworked the outwash deposits into dunes. Layers of clay, silt, and fine sands were formed in areas where water was temporarily impounded in lakes or ponds. The general location of the Site relative to these deposits is shown in Figure 3.2. The Site is situated on the Delong end moraine, which overlies glacial outwash sand and gravel.

3.3.2 Site Specific

Unconsolidated sediments at the Site are up to 220 feet thick, consisting of four major litho-stratigraphic units (Units A, B, C, and D), and overlie carbonate bedrock. Figure 3.3 is a generalized stratigraphic section of the Site, prepared by GRA. The Site-specific stratigraphy was characterized primarily by Mr. Bassett of GRA in a memorandum report to Mr. Wigh of RSC on January 11, 1988. The original framework was refined after extensive drilling work in 1988 and 1989 and presented in the two GRA "Memorandum Reports" (April 28, 1989 and December 15, 1989). The four relatively distinct stratigraphic units and the bedrock encountered at the Site are described in detail in the following subsections. Structure maps for the top of stratigraphic Units B and C and the base of Unit C are provided in Figure 3.4, 3.5 and 3.6, respectively.

Unit A

Stratigraphic Unit A consists of a sequence of four, distinct subunits of loam and silt loam glacial till that probably represent separate phases of glacial deposition. From top to bottom, the stratigraphy is comprised of: (1) a surficial, brown, weathered loam till (subunit A1); (2) a mixture of gray, silt loam and loam till (subunits A2 and A22); and (3) a brittle, hard, olive-gray silty till (subunit A3). Groundwater in the Unit A till sequence occurs in discontinuous perched zones within stratified intertill sand and gravel deposits. Several piezometers and an older series of monitoring wells have been installed in Unit A; however, these wells do not yield significant quantities of water and do not have consistent water level readings.

Unit B

Stratigraphic Unit B (a glacio-lacustrine sequence) underlies Unit A and is comprised of well-stratified, fine to medium-grained sand and interbedded silt. At most locations, a very sharp basal contact with the Unit A till sequence was observed (i.e., a thin weathering zone marked by an oxidized loam or a brown pebbly sand). Although the contact between Units A and B varies considerably in elevation across the facility, Unit B has a relatively uniform thickness of 28 to 42 feet and appears to contain three major silt beds: one near the top, a second in the middle portion, and a third marking the base. The silt bed in the middle portion of the unit seems to be continuous and serves as a marker horizon. The base of Unit B (i.e., the top of Unit C as illustrated on Figure 3.5) is also an irregular surface, with a pattern similar to the top of Unit B and is arbitrarily mapped at the bottom of the lowermost silt bed.

Unit B is interpreted as a subaqueous deposit associated with a prograding delta front. The top of the aquifer (water table) generally lies within Unit B, at an elevation between approximately 725 and 730 feet amsl (Section 3.5.2).

Unit C

Soil samples collected from borings completed through Unit C suggest that the unit consists of glacio-fluvial sediments composed of an upper (upward fining) sequence overlying a lower (upward coarsening) sequence that cuts unconformably and irregularly into an older glacial till (Unit D). The top of the upper sequence is gradational with the overlying Unit B and is arbitrarily placed at the base of the lowest silt bed in Unit B. The upper part of Unit C coarsens downward to a zone of coarse sand, sandy gravel, and gravel, designated as subunit C2.

Subunit C2 is comprised of a more permeable sand and gravel layer that occurs at elevations between 680 and 690 feet amsl. Below subunit C2, the top of the lower sequence is marked by a discontinuous pebbly loam ("diamict") or a zone of massive, gray, silty mud. Fine sands are also found in this interval. The pebbly loam contains abundant stratified material and is interpreted as a proximal mud flow adjacent to an advancing ice lobe. The gray, silty mud and fine sand units possibly represent lower energy deposition in ponded areas adjacent to and resulting from the mud flow(s). Regardless of their origin, the silty mud and fine sands are closely associated, and where present, separate Unit C into an upper and lower sequence.

Although Unit C wells installed in 1988 and 1989 are identified by subunit C1 to C4 designations (e.g., P-27C3), these subunits are not intended to be part of a formal stratigraphic hierarchy. Rather, they are informally defined and relate primarily to the elevation of the coarser "C2" horizon, as well as the relative contacts with Units B and D.

The lower sequence of Unit C thins from north to south. In the northwest quadrant, over 100 feet of sand and gravel underlie the "muddy zone" of Unit C and directly overlie Devonian carbonate bedrock. At the southern margin of the southwest quadrant, the lower sequence of Unit C is approximately 5 feet thick and overlies glacial till (Unit D). The base of Unit C slopes steeply to the north, as illustrated in Figure 3.6. The thickness of Unit D at selected data points is also shown in Figure 3.6.

Unit D

Stratigraphic Unit D consists of unconsolidated loam or finer-textured glacial till that has been entirely removed in certain areas, presumably by glacial meltwater scouring. Where present, the till unconformably overlies carbonate bedrock of Devonian Age. The maximum thickness of Unit D is 47 feet, in the southwest quadrant of the Site. The unit thins abruptly to the north and is cut out by sand and gravel in the lower part of Unit C. The basal portion of Unit D is appreciably more clayey and reddish than the upper portion. It is not known whether this is related to the incorporation of residual clay soil material into the basal portion of a single till unit, or whether two distinct till units exist. No geotechnical analyses of the basal till were performed because of the very mixed nature of the circulated mud-rotary samples from this depth.

Bedrock

Bedrock beneath the facility is comprised of carbonate (limestone and dolomite) bedrock of middle Devonian Age, probably of the Detroit River Formation. Approximately 4 feet of light-gray to dark-brown, fine-to coarsely-crystalline limestone and dolomite were penetrated at four separate locations at the Site. Detailed stratigraphic data and north-south geological cross-sections were prepared by GRA and are provided in Appendix C.

3.4 SOILS

3.4.1 Regional

The regional soils information included in this subsection was obtained primarily from the U. S. Soil Conservation Service document

entitled "Soil Survey of Fulton County, Indiana", which was completed by G. Franklin Furr, Jr., in July 1987. According to Furr, northwestern Fulton County is dominated by the Wawasee soil series, which consists of deep, well-drained, moderately permeable soils formed on glacial till plains and moraines. Slopes range from 2 to 18 percent. The thickness of the upper part of the profile, where soil formation processes are active, is approximately 28 to 40 inches. The A horizon is medium-acid to neutral and consists predominantly of fine, sandy loam and lesser amounts of sandy loam and loam. The B horizon is generally a loam or sandy clay loam, with strongly acid to neutral reactions, and the C horizon is primarily composed of a fine sandy loam or loam. These soil horizons (i.e., A, B, and C) should not be confused with the stratigraphic Units A, B, C, and D.

3.4.2 Site Specific

During past drilling activities conducted at the Site, numerous Shelby tube and split-spoon soil samples were collected, inspected, and analyzed for geotechnical parameters. For example, the Dames & Moore "Hydrogeologic Assessment Report" dated January 12, 1988, presents the results of soil classification tests completed for samples collected during the 1986 and 1987 investigations from the Unit A till sequence (Table 3.1). The sample classifications were determined based upon sieve analysis, hydrometer testing, and/or Atterberg limits testing, and the soils were designated according to the U. S. Department of Agriculture's (USDA's) system and the Unified Soil Classification System (USCS).

The results of laboratory permeability testing for the samples collected by Dames & Moore between 1986 and 1987 are also shown in Table 3.1. In general, the falling head permeability tests indicate that the Unit A soils have permeabilities ranging from 10^{-8} to 10^{-5} cm/sec. Several representative soil samples were also analyzed for cation exchange capacity (CEC) and calcium carbonate equivalency. The CEC results ranged from less than 1 to a high of 18.3 mill equivalents (meq)/100 grams. The higher CEC values were generally measured in the upper glacial soils (Unit A), the interbedded silt layers, and the till material (Unit D) underlying the sand and

gravel aquifer, all of which have moderate to low percentages of silt and clay-size material. The lower CEC values (less than 1 meq/100 grams) were measured in the predominantly sand deposits of the glacio-lacustrine sequence (Unit B) and the glacio-fluvial sequence (Unit C). The soil analytical results and the pH and acid reaction tests completed by Dames & Moore in the field indicated a "closed-environment condition," with no evidence of oxidized or weathered zones from previous soil development within the Unit A till sequence (Dames & Moore, 1988).

During the 1988 and 1989 investigations by GRA, selected soil samples were analyzed for CEC, calcium carbonate equivalency, and texture (including sieve and hydrometer testing). The results of these tests are summarized in Tables 3.2 and 3.3. The CEC values fell into a fairly narrow range, 2.3 to 5.9 meq/100 grams, probably because all of the GRA samples were collected from Unit A. The calcium carbonate equivalency values ranged from 18.8 to 28.8 percent, which are comparable to the data obtained by Dames & Moore during their investigation of Unit A.

3.5 HYDROGEOLOGY

3.5.1 Regional

The regional hydrogeology information included in this subsection was obtained primarily from the CME (Jacobs, 1988). According to Rosenshein and Hunn (1964), "... few water wells have been drilled into the rocks of Devonian [Age]," and "[a]lthough these limestone and shales are not extensively used as a source of water in Fulton County, they are a potential source of water of which quality and quantity available is uncertain." Reportedly, a well located in Richland Township (directly east of the Site) was installed in limestone and had a drawdown of 50 feet after being pumped for 2 hours at 10 gallons per minute (Rosenshein and Hunn, 1964).

Glacio-fluvial sand and gravel deposits are the chief sources of groundwater for domestic, livestock, industrial, and public supplies

in Fulton County (Rosenshein and Hunn, 1964). Both confined and unconfined aquifers are present within the unconsolidated deposits. Wells that tap these aquifers are generally less than 150 feet deep and yield from 5 to 1,000 gallons per minute (gpm). Water hardness typically is between 200 to 450 parts per million (ppm), and iron content is generally higher than the secondary maximum contaminant level (SMCL) of 0.3 ppm established in the Safe Drinking Water Act of 1974. Examples of ionic species concentrations are: iron at 0.1 to 7.5 ppm, bicarbonate at 151 to 532 ppm, sulfate at 5 to 175 ppm, and hardness (as calcium carbonate) at 180 to 540 ppm (Rosenshein and Hunn, 1964).

Glacial till deposits in Fulton County are not a viable source of groundwater. These fine-grained, heterogeneous deposits typically are not sufficiently extensive and cannot transmit water at the rate necessary to sustain yields for even modest domestic supplies (Dames & Moore, 1988).

As reported in the "CAP Task I - Description of Current Conditions" by GRA, groundwater is used for domestic supply at some locations within a 0.5-mile radius of the Site. Appendix D of this RI/FS Work Plan contains private water well logs obtained by GRA from the files of the IDNR Division of Water. The groundwater supply in the general area appears to be derived from the glacio-fluvial aquifer corresponding to the stratigraphic Unit C (GRA, CAP Task I, 1989).

Based on regional topography and nearby surface water locations and elevations, the regional groundwater flow direction appears to be north and northeast, toward the Tippecanoe River. The hydraulic conductivity (permeability) of the glacio-fluvial and glacio-lacustrine aquifers could be expected to fall within the range of 10^{-1} to 10^{-5} cm/sec (Fetter, 1988).

3.5.2 Site Specific

Available records indicate that a total of 118 monitoring wells, piezometers, and water supply wells have been installed on the Site. Table 3.4 contains a list of individual wells and well clusters that are grouped

according to the associated quadrant locations. Monitoring well MW-8 was originally installed as a water supply well for a residence formerly located in the northwest quadrant of the property (GRA, CAP Task I, 1989). In addition, two other water supply wells were identified at the Site, including a 6-inch diameter well in the northwest quadrant and a well located near the former support facilities (trailer) in the southeast quadrant. In addition, the following monitoring wells and piezometers were installed at the Site between 1978 and 1989:

i) seven monitoring wells (MW-1 through MW-7) between December 1978 and February 1979 by water well contractors;

ii) six monitoring wells (MW-20, MW-21S, and MW-22 between May and June 1983, and MW-23S, MW-23M and MW-23L in April 1985) by ATEC;

iii) twelve monitoring wells (MW-21M, MW-21L, MW-24S, MW-24M, MW-24L, MW-24L2, MW-25, MW-26, MW-27S, MW-27M, MW-28S, and MW-28M) and four piezometers (P-1, P-2, P-3, and P-3A) between 1986 and 1987 by Dames & Moore; and

iv) all of the remaining piezometers and wells in 1988 and 1989 by GRA.

A piezometer/monitoring well cluster with a numeric designation of "34*" was installed by GRA between December 1988 and January 1989. The asterisk "*" is not a footnote, but rather a means of distinguishing this cluster from "P-34A," a piezometer formerly located in the northwest quadrant.

Although all of the wells are constructed of polyvinyl chloride (PVC) material, those installed prior to 1988 are constructed according to various specifications. In some cases, the effective well screen length (including the sand pack) is inappropriately long and well casing are attached using glued joints which may contribute organic analytes to samples

collected from these wells. For this reason, several monitoring wells and piezometers will be abandoned as outlined in Section 7.0 of this work plan.

Several rounds of water level data were collected by GRA in 1989 and tabulated according to separate "hydrostratigraphic" units (including Units B, C1, C2, C3, and C4). Water table contour maps generated from these data generally indicate a north to northeasterly groundwater flow direction with a very gentle horizontal gradient and a negligible vertical gradient.

Generalized geologic cross sections were prepared for each of the four Site quadrants, based on data from pre-existing cross sections, soil boring logs, and well construction forms (Appendix E). Figures E.1 through E.4 in Appendix E are provided as a graphical representation of the monitoring points located in each quadrant and the depth of the effective screen lengths relative to the established Site stratigraphy. These figures are not intended to replace the detailed stratigraphic cross sections generated by GRA, but rather to facilitate a visualization of the number and depth of all known groundwater monitoring points in the landfilled area. Several monitoring points have effective well screens longer than 50 feet, and the screened intervals of wells overlap within individual clusters.

As described in the "Hydrogeologic Assessment Report" (January 12, 1988), Dames & Moore completed slug tests in 1987 to determine the hydraulic conductivity at five monitoring wells installed in Units B and C. The hydraulic conductivity values, which were calculated by using two separate analytical solutions, ranged between 10^{-6} and 10^{-4} cm/sec (Table 3.5). By using the average hydraulic conductivity values derived from the field slug tests, the laboratory permeability tests of Unit B and Unit C aquifer material, and representative ranges of the Site hydraulic gradient and effective soil porosity, Dames and Moore estimated groundwater flow velocities between 4.8×10^{-8} and 1.6×10^{-5} cm/sec (0.05 to 17 feet per year).

3.6 CLIMATE

The climate information included in this subsection was obtained primarily from the document entitled "Soil Survey of Fulton County, Indiana" (Furr, 1987). According to Furr, the following climatic data was obtained from the Rochester, Indiana recording station for the period from 1951 to 1974:

i) The average winter temperature was 26 °F, and the average summer temperature was 68 °F.

ii) The lowest temperature on record (-23 °F) occurred on January 29, 1963, and the highest recorded temperature (101 °F) occurred on September 2, 1953.

iii) The average annual precipitation was approximately 37 inches. Approximately 23 inches of rain, or more than 63 percent of the annual total, usually fell between April and September. The heaviest one-day rainfall event during the period was 4.72 inches on April 29, 1956.

iv) Thunderstorms occurred on approximately 40 days each year. Occasional tornadoes and severe thunderstorms were local in extent, lasted for only a short duration, and caused damage in scattered areas.

v) The average seasonal snowfall was about 25 inches, and the greatest snow depth at any one time was 11 inches. On average, 18 days of the year had at least one inch of snow on the ground; however, the number of such days varied greatly from year to year.

vi) The average relative humidity in mid-afternoon was about 60 percent. Humidity was higher at night, and the average at dawn was about 80 percent.

vii) During a 24-hour period, the sun was shining 70 percent of the day in the summer and 40 percent of the day in the winter.

viii) The prevailing wind direction was from the southwest, and the average wind speed was generally highest (i.e., 12 miles per hour) in the spring.

3.7 LAND USE

Fulton County had a population of 17,453 in 1900; 15,577 in 1940; 16,984 in 1970; and 19,208 in 1980. The major concentration of the population is in and near Rochester, which is the largest town in the county. Rochester had a population of 5,016 in 1980. Some of the population is concentrated around other small towns in the area. Agriculture is the main source of income and employment, and the area businesses and industries are relatively small.

During the period from 1958 to 1967, the number of acres of land under urban development increased by about 15 percent, and all categories of agricultural land decreased by the same amount. In 1974, approximately 87 percent of the county remained agricultural land. As of 1987, approximately 100 acres or less were being converted to urban uses, and this trend was expected to continue at a similar rate for several years (Furr, 1987).

The area to the west of the Site is open and used for agricultural purposes, and properties to the north, south, and east are wooded and sparsely populated, with residents situated on scattered, small farms. The primarily white, middle class population is involved in agricultural activities, with no notable distributions by age or sex. Land use consists of small farm and dairy operations. Groundwater is the primary source of potable water for the residents (Agency for Toxic Substances and Disease Registry, 1990).

During a U. S. Geological Survey (USGS) biota study conducted in January 1988, 64 residences and one church were noted on the land within 0.5 mile of the Site. Forty-five of these residences were occupied, and the other 19 appeared to be cottages used only during the summer months (GRA, CAP Task I, 1989).

A plat survey and listing of owners of property adjacent to the Four County Landfill is presented in the CAP Task I report. According to this document, the property immediately north, south, and east of the Site has been separated into many small plats that were never developed.

3.8 ECOLOGY

Mr. Donald Steffeck of the USFWS's Bloomington, Indiana field office prepared a report entitled "A Survey for Contaminants in Selected Biota Near the Four County Landfill, Fulton County, Indiana" (October 1988). This document includes a detailed listing of the fish and wildlife populations supported by the habitat near the Site. During a reconnaissance of the study area, a number of migratory bird species were noted, particularly in the wetland areas. Specifically, the following species were identified during the on-Site inspection: great blue heron; American woodcock; red-tailed hawk; killdeer; mourning doves; and a number of passeriforms, including song sparrows, northern juncos, and robins. A complete listing of the Federal and State-listed endangered species potentially found in Fulton County, Indiana is provided in the original USFWS document.

As part of the USFWS study, fish and wildlife populations were observed near the Site. A relatively high population of white-tailed deer and indications of raccoon, opossum, beaver, Eastern cottontail, fox, squirrel, and chipmunk were noted.

4.0 SOURCE CHARACTERIZATION

The available source characterization data summarized in this section include: (1) the appropriate locations of waste disposal areas and the previous disposal methods used; (2) the type and quantity of wastes that may be contained by the landfill and (3) the interim corrective measures previously completed at the Site. The information presented in this section was garnered primarily from the USEPA's "Hazardous Waste Groundwater Task Force Evaluation of the Four County Landfill, Fulton County, Indiana" dated May 1987.

4.1 HISTORY OF DISPOSAL AND CONTAINMENT

The Four County Landfill began operation in August 1972 and from 1972 to 1978, was licensed as a sanitary landfill by the ISBH. From November 1978 to November 1980, the Site was approved by ISBH to handle separate area waste. From November 1980 until closure in March 1989, the landfill was operated as a RCRA Interim Status facility that accepted hazardous waste for disposal, but did not treat or store hazardous waste (Jacobs, 1988). The facility also accepted sanitary waste for a brief period of time in 1982 to 1983 (Jacobs, 1988).

The area of the Site used for the disposal of waste materials consisted of less than 30 acres (WW Engineering & Science, CAP Task VI, 1990). Areas of unlined deposits are primarily located in the northwest and southwest quadrants, as indicated on Figure 4.1. The portions of the landfill area designated as Cells A, B, and C (located in the southeast quadrant of Figure 4.1) are double-lined disposal units with double-leachate collection systems. Cells A and B are nearly filled to capacity, and Cell C has an unused capacity of approximately 100,000 cubic yards (WW Engineering & Science, CAP Task VI, 1990). Surface water has collected in the lined depression of the unused portion of Cell C.

EWC temporarily stored leachate in aboveground tanks that were initially located in the support facility of the northwest quadrant, and later situated adjacent to the lined cells. A wheel/truck wash with a total capacity of approximately 1,000 gallons is currently located immediately southeast of the support facilities in the northwest quadrant. Rinse water from this unit was periodically removed and transported to the leachate tanks (RSC, 1989). According to the April 13, 1989 "Closure and Post-Closure Plans" prepared by RSC, the maximum inventory at the Site was estimated to be 27,000 gallons of leachate; 385,249 cubic yards of RCRA waste; 51,486 cubic yards of special waste; and 65,000 cubic yards of general refuse (Table 4.1).

4.1.1 Waste Deposits in Unlined Areas

Before 1978, the State of Indiana did not require wastes to be separated as hazardous or non-hazardous. Therefore, the General Refuse Area shown on Figure 4.1 contains a mixture of general refuse, commercial, and industrial waste (USEPA, 1987). During 1974, Fulton County opened a landfill for general refuse, and the volume of general household refuse received at the landfill was reduced (USEPA, 1987). Therefore, between 1974 and 1978, the materials deposited in the General Refuse Area were likely a combination of commercial and industrial wastes (USEPA, 1987).

After 1978, the State of Indiana required disposal facilities to separate general refuse from the commercial and industrial wastes (i.e., the "separate area waste"). The approximate boundaries of the separate area waste deposits are shown on Figure 4.1. Prior to November 1980, EWC did not keep complete records of the volume and types of wastes accepted (USEPA, 1987).

On November 19, 1980, with the aid of a contract survey company, EWC began recording the placement of waste within the individual unlined waste areas (USEPA, 1987). Detailed locations of individual waste deposits within the unlined areas and the respective dates of placement are shown in Figure 4.1. The actual dimensions of these units or cells were not recorded. These small waste management units or cells were excavated and

used on a daily basis (i.e., the "graveyard" method) until the "modified trench" method was adopted by the facility in the spring of 1985. According to information presented in the USEPA's Task Force Report (1987), the graveyard method involved digging a pit (unit) with dimensions of 20 feet by 20 feet by 15 feet (deep), placing the waste within the pit, and backfilling over the waste with excavated soil. The modified trench method was similar to the graveyard method, but individual pits were dug, as necessary, in a line that was called a "trench" and the waste in any unfilled pit was covered daily with soil. Therefore, with the modified trench method of disposal, only a small pit or waste management unit (RCRA landfill cell) was being used at any one time. Although the width of each trench varied and was generally not recorded, the trenches were typically excavated to a depth of approximately 15 feet (USEPA, 1987).

During a June 1986 inspection, the USEPA Task Force noted that EWC was engaging in the lateral expansion of the facility by excavating a new cell measuring 25 feet by 25 feet. According to Mr. James Wilkins, excavating cells and trenches one day prior to disposal was the normal practice for preparing to receive hazardous wastes (USEPA, 1987).

4.1.2 Lined Deposits

Cell A, a waste management unit with a flexible membrane and double-liner systems, was being constructed during the USEPA Task Force inspection in June 1986 (USEPA, 1987). Wastes were placed in this cell beginning on August 18, 1986. Cell A covers an area of approximately 300 feet by 500 feet and the bottom of the cell lies at approximately 760 feet amsl. The base consists of two 80-mil, high-density, polyethylene (HDPE) synthetic liners separated by a drainage mesh that allows for the detection and collection of liquids that may be indicators of liner failure. A second drainage mesh, a permeable geotextile fabric, and 10 to 12 inches of sand are located between the double liner and the waste deposits and were installed to facilitate the collection and removal of leachate (USEPA, 1987). Additional construction details are available in the most recent RCRA Part B Permit Application submissions (June 1987 and January 1988) and the

"Closure and Post-Closure Plans" (April 13, 1989). It is assumed that Cell B and Cell C were constructed on the basis of similar designs. The "area" method of waste disposal was used in the lined cells (Jacobs, 1988). This method consisted of placing the waste in 3- to 5-foot lifts and covering the waste as it is "built out" into the cell. Because a portion of Cell C was constructed in an area that was previously landfilled, the older waste materials may have been excavated and replaced in the double-lined cells.

The leachate production records for Cells A-North, A-South, B, and C were reviewed in an internal memorandum dated January 24, 1990 from Mr. Stephen Pekera of the IDEM Engineering Section to Dennis Zawodni of the IDEM Enforcement Section. Based on this review of graphical data, visual observations, and laboratory analyses of the leachate, IDEM concluded that leaks were present in all of the primary liner systems within the engineered cells. This information suggested the presence of a breach in the primary synthetic liner that allowed leachate to infiltrate into the secondary leachate detection system.

Monthly leachate production records available at the Site for the period of January 1991 through November 1993 were reviewed. The range of monthly leachate production rates for each of the lined cells during this period are summarized below:

Cell	Production Range *(in gallons)*
Cell A	1,200 (October 1993) to 5,000 (February 1991)
Cell B	15,300 (June and July 1991) to 36,500 (March 1993)
Cell C	6,800 (November 1992) to 29,200 (January 1993)

The leachate production values presented represent the sum of the volume of leachate collected from the collection and detection liners for each of the lined cells. These monthly figures correspond to average daily leachate production ranges of approximately 39 to 179 gallons for Cell A, 494 to 1,177 gallons for Cell B and 227 to 942 gallons for Cell C.

Leachate analytical data for several sampling events has been compiled and are summarized in Appendix F.

4.2 IDENTIFICATION OF WASTES

As indicated in the February 26, 1987 RCRA Part A Permit Application, the facility accepted RCRA-hazardous wastes with heavy metals, wastewater treatment sludge, oven residues, petroleum refining wastes, steel mill emission control dust/sludge, lead smelting emission control dust/sludge, and corrosive materials (Table 4.2). According to the June 1987 RCRA Part B Permit Application, the wastes accepted at the Site were generally: (1) listed as hazardous because of the inorganic constituents (heavy metals) present, (2) characterized as hazardous because of corrosivity or Extraction Procedure (EP) Toxicity, or (3) classified as F001 through F005 wastes. Ignitable, reactive, or incompatible wastes were generally not accepted for disposal (EWC, RCRA Part B Permit Application, 1987).

Prior to acceptance and disposal of wastes in Cell A, EWC stated that greater than 90 percent of the wastes accepted for disposal were characteristically nonhazardous (EWC, RCRA Part B Permit Application, 1987); however, the specific methods used to determine hazardous characteristics were not well documented. It is likely that materials containing heavy metals were co-disposed with wastes containing high pH materials (i.e., lime-stabilized treatment residues). Waste was delivered both in bulk and in barrels (EWC, RCRA Part B Permit Application, 1987).

According to the June 1987 RCRA Part B Permit Application, wastes from the following general industrial categories were accepted for disposal at the landfill (not intended to be a complete listing):

- electroplating and metal finishing operations,
- steel manufacturers and fabricators,

- foundries,
- secondary lead smelters,
- paint manufacturers and operations,
- government installations,
- commercial treatment and recovery facilities,
- chemical manufacturers, and
- miscellaneous general manufacturers.

Waste materials were transported to the Site by contracted haulers and generators in tandem, triaxle semitractor/trailer units and roll-off boxes. EWC stated that the approximate daily average was 10 truckloads per day, but ranged between 0 and 50 loads per day depending on weather, scheduling, and other factors. Net load weights generally ranged from 16 to 22 tons, with gross weights up to the legal maximum (EWC, RCRA Part B Permit Application, 1987). Vehicles formerly entered the Site from the southeastern corner, stopping at a laboratory for check-in and on-Site waste analysis before proceeding to individual cells for unloading. After June 1987, the office and laboratory were moved to the eastern parcel of property, across Indiana State Highway 17. Loads were then weighed and examined at that location before proceeding across State Highway 17 onto County Highway 525 North, to the entrance of the northwest quadrant of the facility.

4.3 CORRECTIVE MEASURES

Organic contamination, observed initially as a solvent odor, was encountered in a shallow sand seam within the Unit A till sequence (subunit A1) during the November 1988 installation of piezometer P-34A, located in the northwest quadrant. Piezometer P-34A was constructed

within the boundary of the General Refuse Area, an area of unlined deposits on the western margin of the Site. The piezometer was sampled in November 1988, and several VOCs, namely benzene, carbon tetrachloride, chloroform, and 1,2-dichloroethane were detected in groundwater. In November 1989, the same compounds were detected at higher concentrations, some above their respective aqueous solubility limits. As a result, EWC performed a test excavation in November 1989 and piezometer P-34A was replaced with a large-diameter groundwater recovery sump. Data collected during soil borings and piezometer/sump installation indicate that contamination within the perched water of subunit A1 was caused by lateral groundwater flow from a proximal source within the General Refuse Area, rather than the vertical migration of VOC through the Unit A till sequence (WW Engineering & Science, CAP Task II, 1991).

According to progress reports submitted by EWC to USEPA Region V (RCRA Enforcement), perched water was extracted from the sump between December 1989 and January 1991. As of November 6, 1990, approximately 277,000 gallons of perched water had been extracted from sump P-34A and transported off Site for treatment. A sample of extracted water collected from sump P-34A in April 1990 contained benzene at 27 milligrams per liter (mg/L), carbon tetrachloride at 67 mg/L, chloroform at 10 mg/L and 1,2-dichloroethane at 34 mg/L.

Two spill incidents leading to the deposition of waste materials off Site were reported by EWC (GRA, CAP Task I, 1989). In May 1988, approximately 1/4 cubic yard of dust spilled from a truck on landfill property through the security fence and onto the right-of-way of State Highway 17. IDEM and the Indiana State Police were notified, and the spill was cleaned up immediately. Waste materials, including some sod and soil, were transported to the landfill for disposal (GRA, CAP Task I, 1989).

In June 1988, approximately 75 pounds of treatment sludge (F006) and 1 cubic yard of contaminated gravel were spilled from a truck at the intersection of County Highway 525 North and State Highway 17. IDEM was notified, the cleanup of the material was authorized, and the

materials were transported to the landfill for disposal (GRA, CAP Task I, 1989).

5.0 NATURE AND EXTENT OF CONTAMINATION

Existing laboratory data were used to evaluate the nature and extent of contamination at the Site and to develop RI tasks. However, some uncertainty exists because: (1) full copies of the original data reports and the associated quality assurance information are not available; (2) the existing data were collected during several separate sampling events and by several different organizations (including IDEM, USEPA, and EWC); and (3) the vagaries associated with detection limits, laboratories, and sample handling and collection methods have not been assessed. Despite these limitations, certain data trends have remained consistent over time and can be used to direct the RI tasks.

5.1 GROUNDWATER

As summarized in Section 3.5.2, several rounds of water level data measured by GRA in 1989 show a north to northeasterly groundwater flow direction, with a very gentle horizontal gradient and a negligible vertical gradient. The data indicate that groundwater in Unit A occurs in discontinuous, perched zones, and Unit B and Unit C act as a single, unconfined or partially confined aquifer. The Unit B and C water table elevations measured on November 30, 1989 were represented in the four generalized geologic cross sections prepared by ERM and presented in Appendix E.

5.1.1 On-Site Well Sampling

Quadrant by quadrant summaries of the on-Site groundwater sampling data are provided in Table G .1 through Table G .4, included in Appendix G . These tables contain data associated with monitoring wells and piezometers screened in stratigraphic Units A, B, and C, and were compiled from a database generated at WW Engineering & Science in Grand Rapids, Michigan. The data indicate that the wells and piezometers

installed at the Site were sampled over several different time periods for a variety of analytical parameters. The sampling points are shown on the well and piezometer location map (Figure 5.1). A detailed history of groundwater monitoring at the Site is included in GRA's "CAP Task I - Description of Current Conditions" report dated December 7, 1989, and a general overview is provided in this subsection.

Statistical failures with respect to contaminant indicators were primarily associated with pH in monitoring well MW-20 and TOC in several downgradient wells, which resulted in RCRA assessment groundwater monitoring during the period from 1985 to 1989. Data collected during this period are not consistent, and repeated analyses of volatile and semivolatile organic fractions did not confirm the presence of a groundwater plume. For example, the May 1987 USEPA Task Force Report indicated the presence of hazardous waste constituents in three Unit A monitoring wells (MW-2, MW-5, and MW-7) and one Unit B monitoring well (MW-26). These constituents included 1,1-dichloroethane, chloroform, carbon tetrachloride, phenols, cresols, acetone, benzoic acid, toluene, trichloroethene and naphthalene. In subsequent sampling events, several other constituents were detected in perched water samples collected from Unit A monitoring wells. These other constituents included benzene, tetrachloroethene, bis(2-ethylhexyl)phthalate, 1,2-dichloroethane, 1,1,2-trichloroethane, methylene chloride, carbon disulfide, nitrobenzene and chloroethane.

Perched groundwater samples collected within Unit A near some older areas of the landfill exhibited organic contamination. Although some organic compounds were detected in groundwater samples from Unit B, other than vertical migration from stratigraphically higher units, these sample locations may have been affected during drilling activities by carry-down or cross contamination from Unit A. Concentrations of VOCs in the affected Unit B wells appeared to steadily decrease with each subsequent sampling event.

One Unit B well located in the northwest quadrant (MW-33B) showed consistent detections of 1,2-dichloroethane over time, with no indication of decreasing concentrations. Over the course of

11 sampling events between November 1988 and October 1990, this compound was detected at a maximum concentration of 1,100 micrograms per liter (µg/L). However, the analytical results of groundwater samples obtained from monitoring wells and piezometers screened within Unit B along the northern and northeastern margins of the property (MW-31B, MW-30B, MW-23B, P-8B, and P-7B) did not indicate the presence of VOCs in the downgradient direction.

The compounds detected in perched water within subunit A1 near the P-34A sump area appear to be the result of the disposal of wastes containing VOCs within the General Refuse Area. The migration of VOCs beyond the limits of the General Refuse Area has likely resulted from lateral flow within a perched water zone that occurs in a shallow sand unit at the base of subunit A1. However, the A1 sand unit in the area of P-34A is separated from Unit B by approximately 25 to 30 feet of relatively impermeable glacial till assigned to subunits A2, A22, and A3 of the stratigraphic sequence.

In September 1989, IDEM collected a single round of samples from several Unit C piezometers and detected the following organic analytes within this deeper unit (GRA, CAP Task I, 1989):

- carbon disulfide, which is possibly of biogenic origin;
- 1,2-dichloroethane;
- tetrahydrofuran; and
- diethyl ether.

During the period from September 1984 and December 1987, groundwater samples collected from MW-20 were collected and analyzed for gross alpha and gross beta activity on six occasions. The concentration of gross alpha radiation marginally exceeded the maximum contaminant level (MCL) of 15 picoCuries per Liter (pC/L) on only one occasion during this period (26 pC/L recorded during February 1985). Gross beta exceeded the MCL in groundwater samples collected from MW-20 on

three consecutive sampling events during the period of September 1984 to February 1985. The measured gross beta activity, exceeding the MCL of 50 pC/L, ranged from 81 PC/L to 150 pCL. However, in three subsequent sampling rounds, conducted between September 1986 and December 1987, the concentrations of gross beta were substantially below the MCL and continued to decline steadily during this period ranging from 11 pC/L in September 1986, down to 1.3 pC/L in December 1987.

5.1.2 Off-Site Well Sampling

The sampling and analysis of private water wells in the vicinity of the Four County Landfill began as early as 1981 (GRA, CAP Task I, 1989). In 1986, ISBH sampled domestic water wells near the landfill to address some of the local citizens' concerns. Although some of these wells contained heavy metals and bacteria, the contamination at several residences was attributed to improper well construction or localized sources of contamination such as septic systems or feed lots (ATSDR, 1990).

Since October 1986, several residential wells have been sampled by Fulton County approximately twice a year, using a fund established by EWC. The laboratory data (without a description of the sampling or analytical procedures) have been reported to the Hazardous Substance Committee of the Fulton County Auditor's office by:

- Brookside Farms Laboratory Association, Inc. in Knoxville, Ohio between October 1986 and August 1987; and

- Environmental Health Laboratories in South Bend, Indiana beginning in March 1988.

Trace levels (less than 1 µg/L) of 1,2-dichloroethane have been detected in water samples from the well at the King Lake Baptist Church, located immediately northwest of the Site. Available data generated as a

result of residential well sampling will be compiled and summarized in the RI report.

5.2 SOIL

Field screening measurements obtained by using a photoionization detector (HNu) and the headspace technique suggest the presence of organic contamination in soil beneath the northern portion of the General Refuse Area. Detailed soil screening and analytical sampling have not been completed in other areas of the Site.

5.3 SEDIMENT AND SURFACE WATER

In August 1985, the ISBH collected sediment samples from King Lake for laboratory analyses of 18 pesticides, 17 polychlorinated biphenyls (PCB), 13 metals, and cyanide. No organic compounds or cyanide were detected, and the metals detected in sediment fell within the range of normal background concentrations (GRA, CAP Task I, 1989).

During the 1986 USEPA Task Force investigation, four surface water samples were collected at the following locations:

- the inlet to the culvert beneath County Highway 525 North,
- the southwest retention pond,
- runon at the southwest ditch, and
- runoff from the southwest ditch.

Except for TOC and total organic halogens (TOX), most of the analyte concentrations detected in samples obtained from the southwest

ditch were greater for the runoff than the runon. Several VOCs were detected in the southwest retention pond surface water sample, including toluene at 430 µg/L and 1,1,1-trichloroethane at 160 µg/L, as well as total chromium, lead, and mercury, TOC, TOX, total phenol, and ammonia. The surface water sample collected in the northeast quadrant at the NPDES outfall contained no significant concentrations of contaminants (USEPA, 1987).

As described in the USGS administrative report entitled "Assessment of the Geology, Groundwater Flow, and Groundwater Quality at Four County Landfill, Fulton County, Indiana" (Greeman, 1988), IDEM tabulated the results for four surface water samples collected at the NPDES discharge point in 1986 and 1987. Although no organic chemicals were found in three of these samples, one sample contained 17 VOCs detected at or above 100 µg/L (Greeman, 1988).

5.4 AIR

In May 1988, Dr. Robert B. Jacko, Professor of Environmental Engineering at Purdue University, conducted an air emissions study of the landfill over an approximate 7-hour period, during a typical operating day (GRA, CAP Task-I, 1989). Monitoring and analyses were conducted for suspended particulates, size distribution, particulate adsorbed organics, vapor phase organics, and metals. In his November 1988 report, Dr. Jacko concluded that pollutants were either not detected or were present at concentrations many times lower than established allowable air standards. He also concluded that no pollutants exist in the ambient air downwind from the Site that would compromise the health of individuals working or residing in the area.

5.5 BIOTA

As described in the March 24, 1987 ISBH memorandum, the concentration of metals, total PCBs, pesticides, and pesticide degradation products in fish tissue samples collected from King Lake in August 1985 were below action levels established by the U. S. Food and Drug Administration.

Mr. Donald Steffeck of the USFWS's Indiana Field Office conducted a survey of contaminants in selected biota near the site during the summer of 1987. The report, which was released in October 1988, contains the analytical results for whole-body tissue samples of fish, anurans (frogs and tadpoles), crayfish, and small mammals (mice and shrews). Analysis of the various tissues included organochlorine chemicals, PCBs, and metals. In addition, crayfish tissue was analyzed for polynuclear aromatic hydrocarbons. All of the organisms were collected from areas receiving or potentially receiving surface water runoff from the Site, and the analyte values were compared with those measured in organisms collected from a control area to the northeast of the landfill (Lake Maxinkuckee). The results of the study indicated that the prevalence and concentration of inorganic analytes (i.e., heavy metals) may be statistically greater in tissue samples from biota collected from the wetland basin receiving flow from the NPDES outfall, and from the east-flowing, wooded drainageway to King Lake. Analytes specifically noted were manganese, aluminum, zinc, cadmium, mercury, and nickel. However, during the U. S. District Court hearing concerning the Site, several expert witnesses were deposed by the defense to refute the conclusions of the USFWS study.

6.0 IDENTIFICATION OF ARARs

6.1 PRELIMINARY ARARs

The requirements of the Superfund Amendments and Reauthorization Act (SARA) regarding clean-up actions at CERCLA sites [Sections 121 (d)(1) and (2)] can be summarized as follows:

- The remedial actions selected must attain a degree of cleanup "which assures protection of human health and the environment," and

- When completed, the remedial actions selected must at least attain any "legally applicable or relevant and appropriate standards, requirements, criteria, or limitations".

The USEPA's "CERCLA Compliance with Other Laws Manual: Draft Guidance" (1988) was used to aid in the identification of preliminary ARARs for the Site. Chemical, location, and action-specific preliminary ARARs are discussed in the following subsections.

6.2 CHEMICAL-SPECIFIC REQUIREMENTS

Chemical-specific requirements (i.e., technology or risk-based numerical limitations or methodologies) are used to establish acceptable concentrations of chemicals that may be found at the Site or discharged to the environment. The potential chemical-specific requirements for the Four County Landfill Site include: (1) drinking water maximum contaminant levels (MCLs), (2) non-zero maximum contaminant level goals (MCLGs), (3) Federal water quality criteria (FWQC), (4) IDEM chronic aquatic criteria, (5) Publicly Owned Treatment Works (POTW) pretreatment standards, and (6) State and Federal NPDES regulations.

MCLs are the maximum contaminant levels that are allowed in water delivered to any user of a public water system and are the enforceable drinking water standards established by the USEPA under the Safe Drinking Water Act (SDWA). Pursuant to CERCLA Section 121 (d)(2)(A)(i), MCLs are potential ARARs because they are the enforceable requirements of the SDWA. According to the NCP, MCLs are generally considered an ARAR for groundwater if MCLGs are not an ARAR and the MCLs are relevant and appropriate under the circumstances of the release.

MCLGs are nonenforceable goals for drinking water set by the USEPA under the SDWA. The MCLGs represent contaminant levels with no known or anticipated adverse effects on the health of persons, plus an additional margin of safety. Pursuant to the NCP [40 CFR 300.43 (e)(2)(i)(B)], where the MCLGs are determined to be relevant and appropriate under the circumstances of the release, non-zero MCLGs should be attained by remedial actions for groundwater or surface water that is a current or potential source of drinking water. For a contaminant with an MCLG of zero, the MCL for that contaminant should be attained for current or potential sources of drinking water if the MCL is relevant and appropriate.

Pursuant to CERCLA Section 121(d)(2)(B) and the NCP, 40 CFR 300.430(e)(2)(i)(E), FWQC shall be attained if they are relevant and appropriate under the circumstances of the release. FWQC are nonenforceable guidelines for surface water set by the USEPA under the Clean Water Act (CWA) for the purpose of protecting human health and aquatic life. These quantitative levels of pollutants have been established to ensure that the water quality is adequate for a specified use. Whether FWQC are relevant and appropriate depends on the designated or potential water uses, the media affected, and the purposes for which the FWQC was developed. FWQC are used by states to set water quality standards for surface water, and by State and Federal Agencies for establishing NPDES discharge permit levels. The goals of the FWQC are to protect: (1) humans from hazards associated with drinking contaminated water or consuming aquatic organisms that live in contaminated water, and (2) aquatic life from acute and chronic exposure to pollutants.

The limits on industrial user discharges set by a local POTW are a potential ARAR if discharges to the POTW are a potential remedial alternative. Compliance with pretreatment regulations and standards developed by the POTW helps prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the POTW. Leachate discharges to a POTW are considered in the initial screening of alternatives for the Site; therefore pretreatment regulations and standards set by the POTW are included as potential ARARs.

The MCLs and MCLGs are potential ARARs for monitoring: (1) the groundwater at the site boundaries, and (2) the quality of treated leachate if it is injected into the aquifer. The State of Indiana minimum water quality criteria and the FWQC are potential ARARs for the surface water in adjacent surface water bodies. The POTW pretreatment standards are potential ARARs if leachate is discharged to the POTW.

6.3 LOCATION-SPECIFIC REQUIREMENTS

Location-specific requirements are restrictions placed on the conduct of activities in particular locations. These ARARs relate to the geographical or physical position of the Site rather than the nature of its contamination or the proposed remedial actions. Location-specific requirements may limit and/or impose additional constraints on the type of remedial action that can be implemented at a site.

Restrictions caused by floodplains and wetlands are among the most common location-specific requirements for municipal landfill sites. According to 40 CFR 6.302, remediation of a site located next to wetland areas and/or within a floodplain must be implemented in a manner that: (1) minimizes the loss, destruction, or degradation of the wetland; and (2) preserves the natural and beneficial values of the floodplain. Table 6.1 presents potential location-specific ARARs.

6.4 ACTION-SPECIFIC REQUIREMENTS

Action-specific requirements generally set performance, design, or other similar controls or restrictions on particular kinds of activities related to the management of hazardous substances. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy and are usually technology based. Table 6.2 presents potential action-specific ARARs.

7.0 REMEDIAL INVESTIGATION

7.1 RI RATIONALE

The first step in identifying remedial action alternatives which are consistent with the NCP and protective of potential threats to human health and the environment is the establishment of remedial action objectives.

Preliminary remedial action objectives outlined for the Site and presented in the SOW (as attached to the Agreed Order) include:

i) ensuring that groundwater and surface water quality chemical-specific ARARs are met at the Site boundaries;

ii) minimizing the potential for direct contact with on-Site wastes; and

iii) reducing leachate generation and securing appropriate leachate collection/disposal.

General response actions for remediation at the Site will likely include containing landfill contents, controlling the production and migration of leachate and potentially controlling the migration of landfill gases.

Data gathering objectives of the RI/FS have been focused on obtaining sufficient information to achieve the remedial action objectives outlined for the Site. Data gathering activities have been selected on the basis of known facts and historical information pertaining to the Site and activities conducted thereon. However, in the event data gathering activities identify any additional remedial action objectives necessary to provide protection to human health and the environment, a modification to the RI may be required to achieve these objectives.

Issues of particular relevance at the Site are discussed in the paragraphs which follow.

Groundwater

The pattern of glacial deposition beneath the Site has resulted in a number of potential migration pathways within the unsaturated and saturated zones. Previous Site investigations have identified four unconsolidated stratigraphic unit (Units A, B, C and D) which overlie carbonate bedrock at the Site. Unconsolidated deposits which underlie the Site range from relatively impermeable silty glacial till to highly permeable sand and gravel. The presence of organic contaminants in Unit A in the northwest and southwest quadrants of the Site is likely the result of the lateral migration of leachate. Vertical migration of contaminants in Unit A is likely retarded by the presence of silt and clay within Unit A, while horizontal migration of leachate may occur in sand lenses and perched water zones within this same unit. The primary groundwater-related concern is the presence of Site-related contaminants in Unit A and underlying water-bearing sand and gravel deposits present in Units B and C. Exposure to these contaminants by receptors on and proximate to the Site may pose an unacceptable risk to human health and the environment.

The groundwater beneath the Site contains typical landfill-related contaminants, such as chlorides, in addition to organic and inorganic compounds (Appendix G). Organic compounds which have been detected in collected groundwater samples during previous investigations include VOCs and semivolatile organic compounds (SVOCs). VOCs detected in collected samples included non-halogenated aromatic compounds such as benzene, toluene, ethylbenzene and xylenes (BTEX); halogenated aromatic compounds including chlorinated solvent-related compounds; chlorofluorocarbons such as fluorotrichloromethane; and ketones. SVOCs commonly detected in collected groundwater samples included phenol and phthalate-related compounds. In general, the greatest number and magnitude of organic compound detections occurred in groundwater samples collected from wells and piezometers screened in Unit A. The number and magnitude of organic compound detections decreased in Units B and C.

Inorganic analytes detected in collected samples during previous Site investigations included various metals, nitrates, chlorides, fluorides, sulfides, sulfates. Moreover, gross alpha and beta activity was observed previously.

During the period from September 1984 to December 1987, groundwater collected from MW-20 was analyzed for gross alpha and gross beta activity on six occasions. The concentration of gross alpha radiation marginally exceeded the maximum contaminant level (MCL) on only one occasion during this period. Gross beta activity exceeded the MCL in groundwater samples collected from MW-20 on three consecutive sampling events during the period of September 1984 to February 1985. In three subsequent sampling rounds conducted between September 1986 and December 1987, the concentrations of gross beta were substantially below the MCL and declined steadily during this period. During the RI, the existing analytical database pertaining to gross alpha and gross beta measurements will be evaluated for any potential data gaps.

Although numerous groundwater samples have been collected during previous investigations, analytical results from a consistent network of monitoring wells for a consistent list of analytes are not available. Sampling and quality assurance procedures have been inconsistent. Data for landfill-related constituents will be collected during the RI for comparison to the existing data base and to effectively evaluate remedial alternatives during the FS.

In order to determine the nature and extent of any groundwater contaminant plume as outlined in the Agreed Order, a two-phased approach is planned. During the first phase, existing on-Site monitoring wells will be sampled for likely constituents of concern. A determination regarding further plume delineation activities will be made after evaluation of the results from the initial sampling event. A plan to present the objectives and details of such activities will be submitted to the IDEM and USEPA.

Improper construction of many of the existing Site monitoring wells and piezometers may have facilitated migration of

contaminants between distinct geologic units. These wells and piezometers will be properly abandoned.

Sediment and Surface Water

On-and off-Site sediment and surface water samples will be collected from surface ponds and wetland areas during the RI. These data will determine whether landfill-derived contaminants have moved off Site via overland migration mechanisms and will determine the need for remediation of surface water bodies and wetlands and will also be used for the environmental evaluation discussed in Section 7.4.2.

Baseline Risk Assessment

A baseline risk assessment consisting of a human health risk assessment and an environmental evaluation will be conducted to determine likely contaminant migration pathways and receptors in the absence of remedial actions in order to aid in the selection of the final remedy.

Landfill Cap

The presence of unlined and uncapped waste disposal areas on the Site allows the potential for continued leachate production and contaminant migration. Construction of a low permeability cap over the landfill contents is a remedial action commonly employed at landfill sites. Remedial action objectives for a cap at landfill sites generally include:

i) preventing direct contact with landfill contents,

ii) minimizing leachate production,

iii) controlling surface water runoff and erosion, and

iv) controlling landfill gas emissions.

Depending upon site characteristics, capping may consist of placement of a natural soil cover to construction of a composite-barrier cap. The appropriate cap design ultimately will depend on the technical objectives, risk factors and the ARARs identified for the landfill site.

As a result of the history of disposal and containment at the Four County Landfill Site, final cap design may vary by location across the landfill. For instance, cover requirements for wastes placed in unlined portions of the Site may vary from lined cells.

Placement of a partial cover over the lined portion of the landfill as an interim remedial action would serve to enhance surface drainage and minimize the production of leachate. Partial capping of the landfill is an interim remedial measure which requires evaluation during the RI/FS process. Specific design considerations include:

i) confirming the accuracy of available topographic information;

ii) availability of local borrow sources for construction materials (i.e., clay and native topsoil),

iii) repairing of leachate seeps,

iv) movement of wastes within the lined portions of the landfill, and

v) O&M considerations.

Prior to proceeding with any interim remedial measure, it must be determined whether the measure is consistent with the final remedy.

Leachate

Leachate is currently being collected from the lined portions of the landfill at a rate of approximately 10,000 gallons per week.

Leachate generated at the Site is considered a listed hazardous waste pursuant to 40 CFR 261 Subpart D by IDEM. Generated leachate is currently being transported from the Site by tanker truck to a hazardous waste disposal facility.

7.2 RI SCOPE

The scope of work for the RI at the Four County Landfill Site includes the following work tasks:

i) compilation of pertinent Site background information and updating of this information, as required, as additional data becomes available;

ii) identification of potential chemical, location and action-specific ARARs for the Site (Section 6.0);

iii) conduct Site characterization activities which will confirm the nature and extent of contamination and describe areas of the Site which may pose a threat to human health or the environment; and

iv) complete a baseline risk assessment consisting of a Human Health Risk Assessment and an Environmental Evaluation.

Specific activities which will be conducted during the performance of the RI are detailed in the subsections which follow.

7.3 SITE CHARACTERIZATION

7.3.1 Existing Data

A considerable amount of background information regarding the Site is available in various reports and records. Much of this information was consolidated and presented in the SOW which has been incorporated into the Agreed Order. However, further evaluation of the existing database will be conducted during the RI.

Specific information to be evaluated and summarized during the RI will include:

i) source characterization data;

ii) available records pertaining to residential well sampling; and

iii) available data pertaining to gross alpha and gross beta activity in groundwater beneath the Site.

Each of these tasks are discussed in the paragraphs which follow.

7.3.1.1 Source Characterization

In order to better define the source of contamination and evaluate potential remedial alternatives, an assessment of available existing waste disposal summary information will be conducted. A review of waste types, timing of their receipt and associated disposal methods will be conducted during the RI to the extent the requisite information are available.

Available records regarding the construction specifications of each of the lined disposal cells will be evaluated. A summary of this evaluation will be presented in the RI report.

7.3.1.2 Residential Wells

As summarized in Section 5.1.2, off-Site residential well sampling has been conducted since 1981. The sampling and analysis of residential wells in the vicinity of the Site has not identified the presence of widespread residential well contamination attributable to the Site. Nonetheless, residential well sampling data available from appropriate regulatory agencies will be compiled and summarized in the RI report.

7.3.1.3 On-Site Wells

Occasional exceedences of MCLs for gross alpha and gross beta activity have occurred at one on-Site monitoring location as discussed in Section 5.1.1. In order to further evaluate the significance of this information, groundwater data pertaining to the concentration of gross alpha and gross beta activity in samples from on-Site wells will be compiled and summarized in the RI report.

7.3.2 Field Investigation

The following field tasks will be completed during the RI; however, in the event additional data gathering activities are necessary to adequately characterize the Site and confirm the nature and extent of contamination, these additional data gathering activities will be undertaken in a subsequent monitoring phase.

i) collect and analyze sediment and surface water samples at eight on-Site and 12 off-Site locations;

ii) inspect and inventory each of the existing Site groundwater monitoring wells and piezometers;

iii) abandon 20 existing monitoring wells and piezometers. Additional monitoring wells may be abandoned on the basis of field inspections;

iv) collect and analyze groundwater samples from 71 existing Site monitoring wells;

v) conduct in-situ permeability tests at selected groundwater monitoring wells and piezometers screened in the B and C stratigraphic units;

vi) collect hydraulic head measurements from the network of 71 existing monitoring wells and piezometers;

vii) prepare hydraulic head contour maps for the B and C stratigraphic units from which groundwater flow will be interpreted; and

viii) conduct air screening activities in support of the baseline risk assessment.

Complete descriptions of each of these investigative tasks are provided in the sections which follow. Each of the field sampling activities will be performed in accordance with the SAP which is summarized in Section 8.0.

7.3.2.1 Sediment and Surface Water Investigation

Sediment and surface water samples will be collected to determine the impact of the Site, if any, on surface water and sediments in the vicinity of the Site. Sediment sampling points for eight on-Site locations and 12 off-Site locations are presented on Figures 7.1 and 7.2, respectively. Grab samples will be analyzed for the compounds previously determined to be present or likely to be present including the USEPA's Target Compound List (TCL) and the inorganic analytes on the USEPA's Target Analyte List

(TAL). Additionally, sediment samples will be analyzed for total organic carbon (TOC) in order to determine ecological risk factors. If surface water is present at any of the proposed locations, samples will be collected and analyzed for the same constituents.

On-Site Sampling Locations

A total of eight locations have been selected on the landfill property for sediment and surface water sample collection. In general, these locations correspond to areas of the landfill property which receive surface water discharges from the landfilled areas. These areas include the southwest retention pond and the northeast drainage control basin.

One sediment and surface water sample will be collected from the southwest retention pond adjacent to the unlined waste area (Figure 7.1). This sampling location is likely to contain sediment which has accumulated as a result of surface water runoff from the adjacent landfilled area.

Seven sediment and surface water sampling locations have been selected in the vicinity of the northeast drainage control basin. Five of these are located within the northeast drainage control basin and the remaining two are located near the outlet of the basin. The five samples within the basin are spaced at regular intervals around the perimeter of the basin. The purpose of these sampling locations is to determine the chemical quality of sediments which have accumulated within the basin as a result of surface water runoff from adjacent areas.

Two representative samples of sediment and surface water (if present) will be collected from the low area adjacent to the NPDES discharge point. These samples will be representative of sediment accumulation as a result of discharge from the basin and sediment accumulation as a result of runoff from adjacent land areas.

Off-Site Sampling Locations

Twelve locations off the landfill property have been selected for the collection of sediment and surface water samples. Three separate drainage tributaries receive surface water runoff from the Site as outlined below:

i) a low lying area located at the north of County Highway 525 North which receives runoff from the NPDES discharge point;

ii) a northwest-southeast trending drainageway which directs surface water from the eastern portion of the Site beneath Highway 17, toward King Lake; and

iii) a southeast-northwest trending drainageway which directs surface water across the southwestern portion of the Site toward the Tippecanoe River.

Four sampling locations have been selected for the low-lying area receiving NPDES discharge as described above. One sample will be obtained immediately adjacent to the culvert opposite the NPDES outflow. Two additional representative sampling locations will be selected northwest of this culvert in the lowland area located between County Highway 525 North and County Road 1000 West. The final sample will be collected from the upgradient (western) side of a culvert located beneath County Road 1000 West which allows water to drain into the lowland area between County Road 1000 West and County Highway 525 North.

Three sampling locations have been selected in the northwest-southeast drainageway which directs surface water toward King Lake. Three samples will be collected at regular intervals from the drainageway in the open area located west of the landfilled property to evaluate whether runoff from the Site has impacted this area.

Five sample locations have been selected in the southeast-northwest trending drainageway which crosses the southwestern

portion of the Site. Two sampling locations have been selected at points far enough upgradient to avoid potential influence from a backup of the southwest retention pond. These two locations have been selected as being representative of upgradient surface water and sediment quality in this area. The remaining three sampling locations are from areas receiving surface water runoff from the Site to the open area to the west of the landfilled property. These sampling locations were selected to evaluate impacts which may be present as a result of surface water runoff from the landfilled property.

7.3.2.2 Monitoring Wells and Piezometers

Monitoring Well and Piezometer Inspections

Each monitoring well and piezometer present at the Site which has not been previously buried or abandoned will be carefully inspected. The well inspections will be conducted to determine whether repairs are necessary and to identify monitoring wells and piezometers proposed for sampling or abandonment. A monitoring well inspection form will be prepared for each well inspected. Pertinent information which will be noted during these inspections include:

i) name of the person conducting the inspection;

ii) date and time the inspection was conducted;

iii) condition of locks, well caps, protective covers and concrete pads;

iv) the measured total well depth;

v) presence or absence of well identification marks;

vi) water level; and

vii) any other pertinent comments noted during the inspection.

Total depth measurements recorded at each monitoring well or piezometer will be compared against existing information in order to verify the identity of each well. Additionally, any markings present on the protective casing will be compared against existing total depth data and Site maps to confirm the identity of monitoring wells and piezometers. The confirmed identity of monitoring wells and piezometers will be clearly marked on the outer casing using a paint marker, as necessary, to facilitate future identification.

Inspections of monitoring wells and piezometers will be conducted prior to monitoring well abandonment and groundwater sampling tasks. A complete summary of available monitoring well and piezometer data is presented in Table 7.1.

Monitoring Well and Piezometer Abandonment

A total of 20 existing groundwater monitoring wells and piezometers are proposed for abandonment as listed in Table 7.2. Monitoring wells and piezometers proposed for abandonment include those with excessively long effective screen lengths (i. e. well screens and filter pack) which facilitate hydraulic connection between distinct geologic units and those with inappropriate construction specifications relative to existing standards. Table 7.3 provides a summary of rationale for abandonment of the selected monitoring wells and piezometers. Additional monitoring wells and piezometers may be abandoned on the basis of the results of the detailed inspection. In the event that one or more monitoring wells/piezometers present in the current sampling network are identified for abandonment on the basis of field inspections, IDEM will be notified as to the rationale for the abandonment of these wells/piezometers.

Monitoring wells and piezometers will be abandoned consistent with Indiana regulations (310 IAC 6-10-2) in a manner which minimizes the potential for continued cross contamination between distinct geologic units beneath the Site. In general, monitoring wells and piezometers will be drilled out using a rotary drill rig equipped with either 6-inch (2-inch

diameter wells) or 8-inch diameter (4-inch diameter wells) tricone roller bit using mud rotary drilling techniques. The borings will be advanced to a depth of one foot below the total depth of the monitoring well or piezometer. The boreholes will then be grouted to within five feet of the surface using pure bentonite grout and a tremie pipe. The remainder of the borehole will be backfilled with concrete.

In the event that performing the above-described abandonment procedure is not possible due to terrain, space constraints or well construction, monitoring wells will be abandoned by grouting the well to within five feet of the surface using pure bentonite grout. The remaining annular space will be backfilled to grade using a cement-bentonite grout mixture. The well casing will then be cut off at grade.

Available information indicates that monitoring well MW-8 is a buried residential well constructed of iron pipe. In the event MW-8 cannot be located by visual inspection, a magnetometer will be utilized to identify the location of MW-8. Test trenching may also be employed to locate MW-8.

Monitoring well abandonments will be conducted under the supervision of an Indiana-licensed well driller and an experienced geologist.

7.3.2.3 Groundwater Investigation

In general, the objectives of installing and sampling a monitoring well network at a landfill site is to determine whether disposal practices have adversely affected groundwater underlying the site and the potential consequences of any impacts. Data requirements for a monitoring well network include information pertaining to:

i) subsurface geology;

ii) the nature and extent of groundwater contaminants beneath the site;

iii) the characteristics of aquifers underlying the site including depth to water, direction of groundwater flow, groundwater flow rates and conductivity of various geologic units;

iv) identification of potential migration pathways and receptors; and

v) the location of contaminant plumes and potential source areas.

As outlined in the first five sections of this work plan, a significant database has already been compiled pertaining to geologic and hydrogeologic conditions beneath the Four County Landfill. However, additional tasks are required to adequately determine; the nature and extent of contaminants present beneath the Site, the location of any contaminant plumes and to obtain further detail regarding hydrogeology of various stratigraphic units present beneath the Site.

Groundwater Sampling

In order to obtain a groundwater analytical database for a consistent list of parameters under strict QA/QC protocols to supplement the existing groundwater analytical database, groundwater samples will be collected from a network of existing monitoring wells and piezometers. Monitoring well locations were selected to achieve extensive areal coverage of the Site and to collect representative groundwater samples from Units A, B and C, extending down to the more permeable subunit C2. Additionally, monitoring wells were selected for the sampling network on the basis of compatibility with existing industry construction standards.

A total of 71 existing wells and piezometers (i.e., groundwater sampling points with reasonable screen lengths and construction specifications) will be sampled as part of the first phase of the Site characterization. This number of groundwater sampling locations may be adjusted after well/piezometer inspections as outlined in Section 7.3.2.2.

Wells installed below subunit C2 will not be sampled, but retained for future use, depending on the results of the initial round of groundwater sampling. Table 7.4 summarizes the monitoring well network for the Site.

Water level and total depth measurements will be obtained at each sampling point. Moreover, a photoionization detector (PID) will be used to screen for the presence of VOCs at the well head. A minimum of three times the volume of water standing in the well or piezometer casing will be removed during the purging process, and measurements of temperature, pH, and specific conductivity will be recorded to confirm attainment of equilibrium conditions with the aquifer. Further details on monitoring well purging are provided in the Field Sampling and Analysis Plan (FSAP) summarized in Section 8.0..

To determine the extent of potential groundwater contamination attributable to the Site, one round of groundwater samples will be collected and analyzed for constituents determined to be present on the basis of previous sampling data and constituents likely to be present on the basis of wastes disposed of at the Site. This constituent list includes TCL VOC, TCL semivolatile organic compounds (SVOC), TAL total and dissolved metals, TAL total cyanide, and the following landfill leachate indicator parameters:

- pH,
- sulfate,
- chloride,
- nitrate,
- ammonia,
- total dissolved solids (TDS),
- total suspended solids (TSS), and
- alkalinity.

The analyses of these organic and inorganic parameters will allow for a thorough evaluation of potential impacts from the landfill materials. Analytical methodologies and procedures which will be adhered to during the RI/FS are provided in the FSAP summarized in Section 8.0.

Permeability Testing

In-situ permeability testing (i.e. slug testing) will be conducted at the eight monitoring wells listed in Table 7.5. These monitoring wells are representative of monitoring wells screened in the B and C stratigraphic units in each of the quadrants of the Site. The purpose of conducting permeability testing is to determine the range of in-situ hydraulic conductivities for various stratigraphic units and to compare these data against existing data.

Hydraulic Monitoring

A significant database pertaining to groundwater flow has been compiled during previous investigations conducted at the Site. These investigations have demonstrated that the general direction of groundwater flow in overburden deposits is toward the northeast. However, some variability exists in the data produced to date. In addition to the temporal effects of the hydrologic cycle, variability in the groundwater flow data may result from:

i) variation in the number of data points from event to event;

ii) use of different benchmarks during surveying of monitoring wells;

iii) use of improper or inconsistent protocol during collection of hydraulic head data;

iv) use of hydraulic head data collected from wells with excessively long screened intervals;

v) differential well settlement over time; and

vi) errors in interpretation of hydraulic head data.

During the RI, two sets of hydraulic head data will be collected from each of the 71 monitoring wells in the sampling network. Additionally, the elevation of a point at the top of the casing of each monitoring well in the sampling network will be established to the nearest 0.01 foot and referenced to mean sea level datum by a registered land surveyor.

Data compiled during hydraulic monitoring tasks will be used to prepare groundwater contour maps for stratigraphic units B and C. Additionally, the horizontal and vertical direction of groundwater flow beneath the Site will be determined.

Further Plume Delineation

On the basis of the current database, it can not be determined whether a groundwater contaminant plume is present beneath the Site. Groundwater data collected during the initial sampling round will be evaluated and a determination regarding additional tasks necessary to characterize the nature and extent of contamination, will be made. A technical memorandum summarizing the sampling data will be submitted to IDEM and USEPA within 30 days of receipt and validation of groundwater data and will, at a minimum, address the following:

i) a summary of contaminants detected during previous investigations;

ii) analytical data compiled during the RI;

iii) the need to conduct additional groundwater sampling at existing on-Site monitoring wells and piezometers, the identity of monitoring wells to be sampled and stratigraphic units to be monitored;

iv) recommendations for the location and construction of any additional monitoring wells required to characterize the nature and extent of contamination;

v) recommendations for a specific list of analytes to be monitored during supplemental groundwater sampling events; and

vi) amendments to the RI schedule as required to perform additional plume delineation activities, if necessary.

Data compiled during the RI pertaining to groundwater quality and groundwater flow will be compared to the existing database. This will determine whether, and the extent to which conditions at the Site may have changed in the intervening period since the last groundwater data were collected. If a groundwater plume originating from the Site is identified, a sample will be collected from the most adversely-impacted monitoring well located within this plume. This sample will be analyzed for Appendix IX parameters, as well as biological oxygen demand (BOD) and chemical oxygen demand (COD), in support of potential treatability studies and an evaluation of potentially feasible remedial technologies.

Since the extent and magnitude of a contaminant plume attributable to the Four County Landfill has not been established, it is not possible to determine which residential wells, if any, could potentially have been impacted by the Site. However, as summarized in Section 5.1.2, sampling and analysis of residential wells in the vicinity of the Site has not identified the presence of widespread residential well contamination attributable to the Site.

7.3.3 Air and Landfill Gas Screening

Disposal of municipal wastes as well as hazardous waste occurred at the Site. Emissions of VOCs and airborne particulates may be of concern at any hazardous waste disposal site. However, VOCs and toxic metals were not detected at elevated levels during the 1988 air monitoring

survey conducted during active operation of the landfill. At landfills such as the Four County Landfill where municipal solid wastes were disposed in addition to industrial and hazardous wastes, methane gas production resulting from the degradation of municipal solid wastes may result. The Four County Landfill also accepted wastes derived from metals plating and finishing operations.

On the basis of the information presented above, emissions of methane gas, VOCs, hydrogen sulfide and hydrogen cyanide have been identified for further review. Nevertheless, it is noted that he 1988 air monitoring survey concluded that emissions of suspended particulate matter from the Site were within the established limits for the protection of human health. Moreover, the 1988 air monitoring survey was conducted during a period when the Site was active and air sampling equipment was placed directly downwind of an area were trucks were actively disposing of waste (Jacko, R. B., November 1988).

Since particulate emissions under current Site conditions may be expected to be a fraction of the particulate emissions from the Site under operating conditions, monitoring for particulate emissions will not be conducted during the RI. However, the rate and duration of landfill gas generation varies and is dependent upon refuse composition, age of refuse, moisture content, pH, temperature as well as various other factors. Since the 1988 air monitoring survey was conducted when the landfill was active, the rate of landfill gas production may differ between the present and the time the 1988 survey was conducted. Therefore, as a result of the difference in conditions between the present and the time the 1988 survey was conducted, screening for vapor phase constituents of concern will be conducted during the RI.

The objectives of the air monitoring program to be conducted at the Site are to screen for the compounds of concern and to provide data suitable for use in developing the baseline risk assessment discussed in Section 7.4. A discussion of the field monitoring program for the vapor phase compounds of concern is provided in the paragraphs which follow. The SAP is summarized in Section 8.0.

7.3.3.1 Meteorological Conditions

Obtaining certain meteorological data is required in order to properly evaluate the air survey data which will be collected during the RI. Meteorological data of importance includes wind speed and direction, temperature, barometric pressure, and relative humidity. These data will be collected at hourly intervals during air sampling activities. Meteorological data will be collected using direct reading instruments. Additionally, general meteorological observations (overcast conditions, presence/absence of precipitation events, occurrence of fog and haze, etc.) will be recorded regularly during the air sampling program.

Every effort will be made to conduct the air monitoring under conditions of steady wind speed and direction. However, if a significant change in wind speed or direction is noted during an air sampling event, these observations will be accurately recorded in the field log.

7.3.3.2 Site Inspection

In order to identify areas of the landfill where significant landfill gas emissions may be occurring, a detailed inspection of the landfill will be conducted. The Site inspection will be conducted on a 100 foot by 100 foot grid pattern. During the Site inspection, a portable combustible gas indicator will be used in order to screen for the presence of combustible gases. Additionally, detailed observations will be made in order to determine likely areas where landfill gas may be discharging to the surface. Such areas may be identified by lack of vegetation, the presence of deep cracks or fissures in the soil cover, gas bubbles in ponded areas and odors which may be present. In these areas the combustible gas indicator will be used in an attempt to locate the general area where landfill gas discharge is occurring. If any landfill gas discharge areas are noted during the inspection, these locations will be clearly marked in the field.

7.3.3.3 VOC Monitoring

The potential presence of VOCs contained in landfill gas emitted from the Site represents the primary concern requiring evaluation during the air pathway analysis. In order to evaluate VOC emissions which may be of concern to the population surrounding the Site, VOC monitoring will be conducted. Ten air samples will be collected during two separate sampling events. Six samples will be collected from the landfilled area in close proximity to landfill gas discharge locations identified during the inspection of the Site, the remaining four samples will be collected at the limits of the landfilled area (i.e. at the fence line). The sampling locations at the landfill limits will be configured such that one sampling point will be located upwind and three sampling points located downwind of the landfill. In the event no gas discharge areas are identified during the Site inspection, the six on-Site sampling locations will be selected randomly such that three sampling points are located in lined landfill areas and three sampling points are located in unlined landfill areas.

Air samples will be collected for VOC analysis using precleaned, evacuated stainless steel Summa® canisters equipped with pneumatic flow regulators. VOC determinations will be performed in accordance with USEPA Compendium Method TO-14. This VOC monitoring method is compound-specific, relatively sensitive and will allow identification of specific compounds at relatively low quantitation limits for use in assessing Site risk.

In addition to the landfill, potential significant VOC sources in the vicinity of the Site include automobile exhaust emissions from State Route 17 and exhaust from machinery conducting Site operations and maintenance. Every effort will be made to locate sampling points as far away from outside VOC sources such as the highway. Operation of equipment at the Site which may act as a VOC emission source will be curtailed during the sampling events.

7.3.3.4 Hydrogen Sulfide and Hydrogen Cyanide Screening

Screening for hydrogen sulfide and hydrogen cyanide gas will be conducted at the Site using portable direct-reading instruments. These instruments will produce real-time compound-specific data which will be recorded in the field log at the time of collection. Typically, these instruments have a sensitivity of one part per million. During the two air sampling events, direct readings for hydrogen sulfide and hydrogen cyanide will be obtained hourly by walking the perimeter of the Site. Readings will be recorded at 100-foot intervals during the perimeter walk. In the event a reading is observed between the sampling nodes, the reading will be recorded and the location noted for future data confirmation. Additionally, if landfill gas discharge areas are identified during the inspection, hydrogen cyanide and hydrogen sulfide readings will be recorded at the gas discharge locations.

7.3.3.5 Methane Gas

Screening for methane will involve the conduct of a soil gas survey in order to assess the potential for landfill gas migration through the subsurface beyond the perimeter of the landfill. The soil gas survey will be conducted at 100-foot intervals around the perimeter of the landfill near the fence line. However, sampling points for methane screening will not be conducted in areas where excessively wet soil conditions or standing water are present.

The soil gas sampling procedure involves insertion of a probe to a depth of approximately two feet below ground surface and use of a vacuum to draw a sample of soil gas through the probe. The concentration of methane will then be recorded using a direct reading instrument. The probe will be withdrawn upon completion thus eliminating the need for a permanent monitoring installation. The soil gas survey will be conducted once during the RI.

7.4 BASELINE RISK ASSESSMENT

A baseline risk assessment will be conducted and will consist of a human health risk assessment and an environmental evaluation. The baseline risk assessment will determine the threats posed by Site contaminants to human health, identify potential migration pathways and receptors. These data will be used to aid in the selection of an appropriate remedial action alternative.

7.4.1 Human Health Risk Assessment

The data gathered during the RI/FS will include chemical analyses of groundwater, sediment and surface water. The results of these analyses will be used to estimate exposure point concentrations of the chemical parameters detected.

To conduct the baseline RA, the most recent versions of the following USEPA guidance documents will be utilized:

- Superfund Exposure Assessment Manual (SEAM),
- Integrated Risk Information System (IRIS), and
- Exposure Factors Handbook (EFH).

In addition, the following USEPA documents from the Risk Assessment Guidance for Superfund (RAGS) Volume I will be utilized during the RI/FS process:

- Part A - Human Health Evaluation Manual (Interim Final, December 1989);
- Part B - Development of Risk-Based Preliminary Remediation Goals (Interim Final, December 1991);

- Part C - Risk Evaluation of Remedial Alternatives (Interim Final, December 1991);

- Supplemental Guidance, Standard Default Exposure Factors OSWER Directive 9285.6-03, March 25, 1991;

- Supplemental Guidance to RAGS, Calculating the Concentration Term, Volume 1, No. 1, May 1992;

- Health Effects Assessment Summary Tables (HEAST); and

- Dermal Exposure Assessment: Principles and Applications (EPA/600/8-91/011B, January 1992).

The exposure assessment will be conducted by an experienced toxicologist and will describe the type and extent of human contact with various media.

The risk assessment will be based on environmental monitoring data and other information obtained prior to and during the RI.

The identification of chemicals of concern (COCs) may use several objective approaches which numerically evaluate the concentrations, frequency of occurrence and toxicity of the reported chemicals and, by applying selected criteria, identify the primary chemicals in a specific media. This is consistent with USEPA guidance document RAGS, Volume I, Part A, "Human Health Evaluation Manual."

The primary criteria used to identify Site-specific COCs are:

i) detection frequency/concentration/toxicity criteria; and

ii) background concentration criteria.

All chemicals reported in at least one sample, in each media, will be included in the preliminary evaluation. Chemicals will be qualified on the basis of either their carcinogenic or non-carcinogenic scores. Those chemicals that contribute one (1) percent or greater to the total score for either carcinogens or non-carcinogens meet the toxicity criteria. Chemicals with relatively low carcinogenicity or non-carcinogenic scores are excluded from the risk assessment, as their contribution to the total health risk from the Site is expected to be low. Therefore, COCs identified will represent those chemicals that pose the highest potential risk and account for the vast majority of the total risk.

The detection frequency/concentration/toxicity score for a suspect carcinogen is calculated using the following equation:

$$SCORE = DF * C * CSF$$

where:

DF = detection frequency which is the number of detections per total number of samples.

C = maximum concentration reported in non-background samples of the media evaluated.

CSF = Cancer Slope Factor which is an estimate of the cancer producing potency of a chemical and is modeled based on the data from experimental and epidemiological data which show carcinogenic effects of specific chemicals.

The detection frequency/concentration/toxicity score for the non-carcinogenic effects of a chemical is calculated using the following equation:

$$SCORE = DF * \frac{C}{RfD}$$

where:

DF = detection frequency which is the number of detections per total numbers of samples.

C = maximum concentration reported in non-background samples of the media evaluated.

RfD = Reference Dose or the dose that is believed to not produce adverse effects even after long-term exposure.

Note that the inclusion of the chemical-specific detection frequencies in the carcinogenic or non-carcinogenic scores addresses the prevalence of the chemical in the media of interest. Therefore, if a chemical is detected in only a few samples at low concentrations, the chemical is less apt to be identified as a COC. Chemicals that have high toxicity and high concentrations in only a few samples will still be evaluated because of high scores.

To be identified as a COC, a chemical has to be reported as present in at least one sample of the media being evaluated at a concentration greater than twice the concentration reported in the Site-related background samples for the same media (consistent with selection procedures identified in the USEPA 1989b). The mean concentrations reported are evaluated against mean concentrations in the Site-related background samples."

The risk assessment will be organized into the following four basic sections:

i) contaminant identification,

ii) exposure assessment,

iii) toxicity assessment, and

iv) risk characterization.

In the exposure assessment, present or potential routes of exposure will be identified and the potential magnitude of exposures will be characterized. Based on the information compiled to date, the following are the potential exposure pathways:

i) direct (dermal) contact with chemicals in groundwater, sediment and surface water; and

ii) ingestion of chemicals in groundwater, sediment and surface water.

A complete exposure pathway is comprised of four components: (1) the source area; (2) transport medium; (3) potential receptors; and (4) likely routes of exposure. Exposure pathways will be classified as complete if the four components are present, may have been present or may be present in the future. The complete exposure pathways will be further evaluated, potential exposure point concentrations will be measured or estimated, and chemical intakes will be calculated.

Human exposure is expressed in terms of intake which is equivalent to the amount of a substance taken into the body per unit body weight per unit time. Chemical intakes will be estimated based on the frequency and duration of exposure and the rate of media intake (e.g., amount of soils contacted per day). Daily intakes will be averaged over a lifetime (70 years) for carcinogenic effects and over a shorter exposure duration for non-carcinogenic effects. In accordance with the guidance documents, calculated intakes will represent a "reasonable maximum exposure". The risk assessment will include a discussion of the uncertainties in the exposure estimates. A given population may be exposed to a chemical from several exposure routes. The risks and hazards across pathways will be summed only if it is deemed appropriate based on the likelihood "that the same individuals would consistently face the reasonable maximum exposure by more than one pathway (USEPA RAGS, pg. 8-15)".

In the risk characterization, the potential health risks associated with exposures to chemicals of potential concern will be quantified.

Non-carcinogenic health effects will be evaluated by comparing calculated intakes with appropriate RfDs established for the protection of human health. Carcinogenic health effects will be evaluated by calculating the regulatory estimated incremental cancer risk associated with exposure to chemicals of potential concern using established potency factors.

7.4.2 Environmental Evaluation

A separate Environmental Evaluation Report will be prepared and will be compliant with the requirements set-out by the following:

- RAGS Volume II - Environmental Evaluation Manual (Interim Final, March 1989), and

- Region V Regional Guidance for Conducting Ecological Risk Assessments (April 1992).

The Environmental Evaluation Report will summarize the existing, published information pertaining to the Site, including: (1) a description of the Site's physical conditions, (2) a listing of critical habitats and an updated listing of state and federal threatened and endangered species, (3) a toxicity assessment of Site contaminants, (4) an assessment of the potential for adverse ecological effects from exposure to the contaminants including presentation of sediment and surface water data compiled during the RI, and (5) available wetland delineation information from state and federal sources. A full toxicological assessment of flora and fauna will not be performed unless data collected during the RI indicate that such a study is necessary.

The identification of sensitive populations will be completed in accordance with USEPA RAGS Part B: "Environmental Evaluation Manual". Sensitive human populations that may potentially be exposed to Site-related chemicals of concern will be identified based on the location of current populations relative to the Site and the current land use of the Site and its surrounding area. Information gathered as part of the Site assessment or during the initial stages of the remedial investigation,

population surveys conducted near the Site, topographic maps, land use maps, zoning maps, housing maps or other information (i.e., U. S. Bureau of the Census) may be used to determine human population that may be exposed under the current Site conditions. A listing of state and federal threatened and endangered species will be included in the environmental evaluation. In addition, the Indiana Department of Natural Resources - Division of Nature Preserves, upon request, will provide a listing and location of all critical habitats for endangered or threatened species existing on or in the vicinity of the Site which require special attention or protection. Certain types of environments, such as wetlands, requiring special consideration or protection will also be identified. This information will be incorporated into the Environmental Evaluation.

8.0 SAMPLING AND ANALYSIS PLAN

A Sampling and Analysis Plan (SAP) developed such that all RI/FS activities are performed in accordance with established and accepted protocols has been prepared and is presented in Appendix H. The SAP consists of both the FSAP and QAPP. The FSAP details all monitoring well installation and soil and groundwater sampling procedures to be utilized during the RI/FS. The QAPP details the analytical methodologies and procedures to be strictly adhered to during the RI/FS so that accurate and valid data are obtained.

9.0 FEASIBILITY STUDY

An FS will be conducted in accordance with the Agreed Order. The FS will be used to assist in the selection of a Site remedy which is protective of human health and the environment. The FS will be prepared utilizing the existing historical data in conjunction with the data compiled during the RI. The FS will identify and evaluate a limited group of Remedial Action Alternatives (RAAs). A Site remedy will be selected from the list of RAAs which meets the remedial response objectives for the Site and provides adequate protection to human health and environment.

9.1 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

The initial document to be prepared during the FS will be the Alternatives Array Document (AAD) which will discuss appropriate treatment technologies for a closed or partially closed municipal and hazardous waste landfill, screen the appropriate treatment technologies and assemble the retained technologies into a limited number of RAAs. Key components of the AAD will include:

i) a discussion of the specific remedial action objectives, ARARs, and general response actions;

ii) a summary and listing of potentially-applicable remedial technologies;

iii) an evaluation of the contaminant source, potential exposure pathway(s) and affected media or human and ecological receptors based upon existing Site data and data compiled during the RI;

iv) development and application of screening criteria based upon USEPA feasibility study evaluation criteria and engineering

judgment to assess each of the potentially-applicable treatment technologies; and

v) assembly of retained technologies into a limited number of RAAs.

The preliminary ARARs and RAAs developed and presented in the SOW and the RI/FS Work Plan will be reviewed and modified as necessary in the AAD. The AAD will be submitted to IDEM for review and comment. The final AAD will provide the basis for a detailed analysis of RAAs.

9.2 DETAILED ANALYSIS OF RAAs

The major effort conducted as part of the FS for the Site will be a detailed evaluation of the applicable remedial alternatives identified in the AAD that are appropriate for further analysis and review. Each alternative will be evaluated with respect the following criteria:

- Overall protection of human health and environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume of materials;
- Short-term effectiveness;
- Implementability;
- Cost;
- USEPA and IDEM acceptance; and
- Community acceptance.

The alternatives will be compared with respect to the relative satisfaction of each of the aforementioned criteria in a draft FS Report, which will be prepared for IDEM's review. After IDEM's comments have been addressed, the final FS Report will be prepared.

10.0 HEALTH AND SAFETY PLAN

A HSP is required such that all RI/FS activities are performed safely and in accordance with applicable regulatory requirements, and that all persons at the Site, the general public and the environment are protected from potential exposure to Site-related compounds.

The HSP for the RI/FS is presented in Appendix I and shall be adhered to during the implementation of the RI/FS activities outlined herein.

11.0 PERMIT REQUIREMENTS

The Agreed Order requires the development and submission of a plan to satisfy RI/FS permitting requirements. Major activities to be performed as part of the RI include monitoring well abandonment, sediment sampling, surface water sampling and groundwater sampling. Future RI/FS tasks may include installation of off-Site groundwater monitoring wells.

Abandonment of existing groundwater monitoring wells does not require permits in the State of Indiana. Permits may be required for the installation of off-Site monitoring wells in the vicinity of designated wetlands areas as stipulated by the Clean Water Act. However, the configuration of an off-Site monitoring well network, if required, will not be finalized until the completion of the groundwater sampling tasks detailed herein. Any off-Site monitoring wells which will be installed in a wetland area will be identified when an additional characterization activities are identified and submitted to IDEM.

Permits are not required in order to complete the other RI/FS work tasks at the Site as identified by this Work Plan. Since it is the intent of IDEM and the Group that actions conducted at the Site be consistent with CERCLA, future activities conducted are eligible for the permit exclusion provided by Section 121 of CERCLA. However, the Group will work closely with IDEM and USEPA to identify any permits which may be required, and to ensure that all required permits are obtained, or the substantive requirements of permits are identified and adhered to for on-Site activities.

12.0 REPORTING

As outlined in the SOW and Section X of the Agreed Order, the following reports are required for submission to IDEM and the USEPA:

i) RI/FS Work Plan;

ii) RI Report;

iii) Alternatives Array Document;

iv) FS Report;

v) Environmental Evaluation Report; and

vi) Monthly Progress Reports.

In addition, a technical memorandum summarizing analytical data and any additional characterization activities necessary will be prepared for submission to IDEM and USEPA.

Each of the above submittals, with the exception of the monthly progress reports, will be submitted in draft to IDEM and the USEPA. Reports will be revised and resubmitted within 30 days of receipt of comments from IDEM and USEPA.

12.1 MONTHLY PROGRESS REPORTS

Monthly reports summarizing the progress of RI/FS activities conducted during the previous month and operation and maintenance of the Site will be prepared and submitted to IDEM and USEPA. At a minimum, monthly reports will include the following information:

i) status of work and progress made as of the date of the report;

ii) percentage of work completed and schedule status;

iii) difficulties encountered and corrective actions undertaken;

iv) deviation from the schedule provided in the RI/FS Work Plan;

v) activities planned for the next reporting period;

vi) any changes in key project personnel;

vii) logs of trucks entering and leaving the Site;

viii) information on the amount of leachate transported off site, data of transport, transporter and the disposal facility;

ix) dates of sampling activities conducted at the Site; and

x) provide analytical data pertaining to Site maintenance activities.

Monthly progress reports for the previous months activities will be submitted by the tenth business day of each month. A copy of each monthly progress report will be forwarded to a designated representative of the STOP Group.

12.2 RI REPORT

The RI report will present the data compiled during the RI. The RI report will present and analyze the data collected and pertinent conclusions pertaining to the status of the Site. The RI report will also present the baseline risk assessment.

Groundwater analytical data generated during the investigation will be evaluated upon receipt from the laboratory. In the event an evaluation of the data indicates the potential presence of a Site-related groundwater contaminant plume, a plume delineation plan will be prepared as identified in Section 7.3.2.3.

12.3 FS REPORT

The FS report will be submitted after the RI Report and AAD have received approval from IDEM. The FS Report will evaluate suitable remedial alternatives based upon risk, implementability and costs.

13.0 PROJECT ORGANIZATION AND SCHEDULE

13.1 ORGANIZATION

The project organization and management structure for implementation of the RI/FS is presented in Figure 13.1. The project organizational chart presents the names of key project personnel which have been identified for the implementation of the RI/FS. In the event key personnel change during the project notification will be provided in writing at least five calendar days prior to such a change in accordance with the Agreed Order.

13.2 PROJECT SCHEDULE

The schedule for implementation of RI/FS work tasks is provided in Figure 13.2. The schedule may be subject to revision due to adverse weather during implementation of the field work or the need to implement additional characterization activities. In the event additional characterization activities are necessary, a revised schedule will be submitted with the technical memorandum.

14.0 SITE OPERATION AND MAINTENANCE PLAN

The Site operation and maintenance manual as required by the Agreed Order (Section IX, Paragraphs 38 and 44) and detailed in Section V of the SOW is presented as Appendix J .

15.0 COMMUNITY RELATIONS

As outlined in Section 101 of the Agreed Order, IDEM shall conduct community relations activities as necessary with guidance from the NCP. The Respondents will cooperate with IDEM in providing information about the RI/FS to the public. IDEM will give Respondents notice of, and may require attendance, at public meetings which IDEM may hold or sponsor.

A Site information file will be maintained by IDEM at a repository near the Site. Respondents will be notified of the location of the repository.

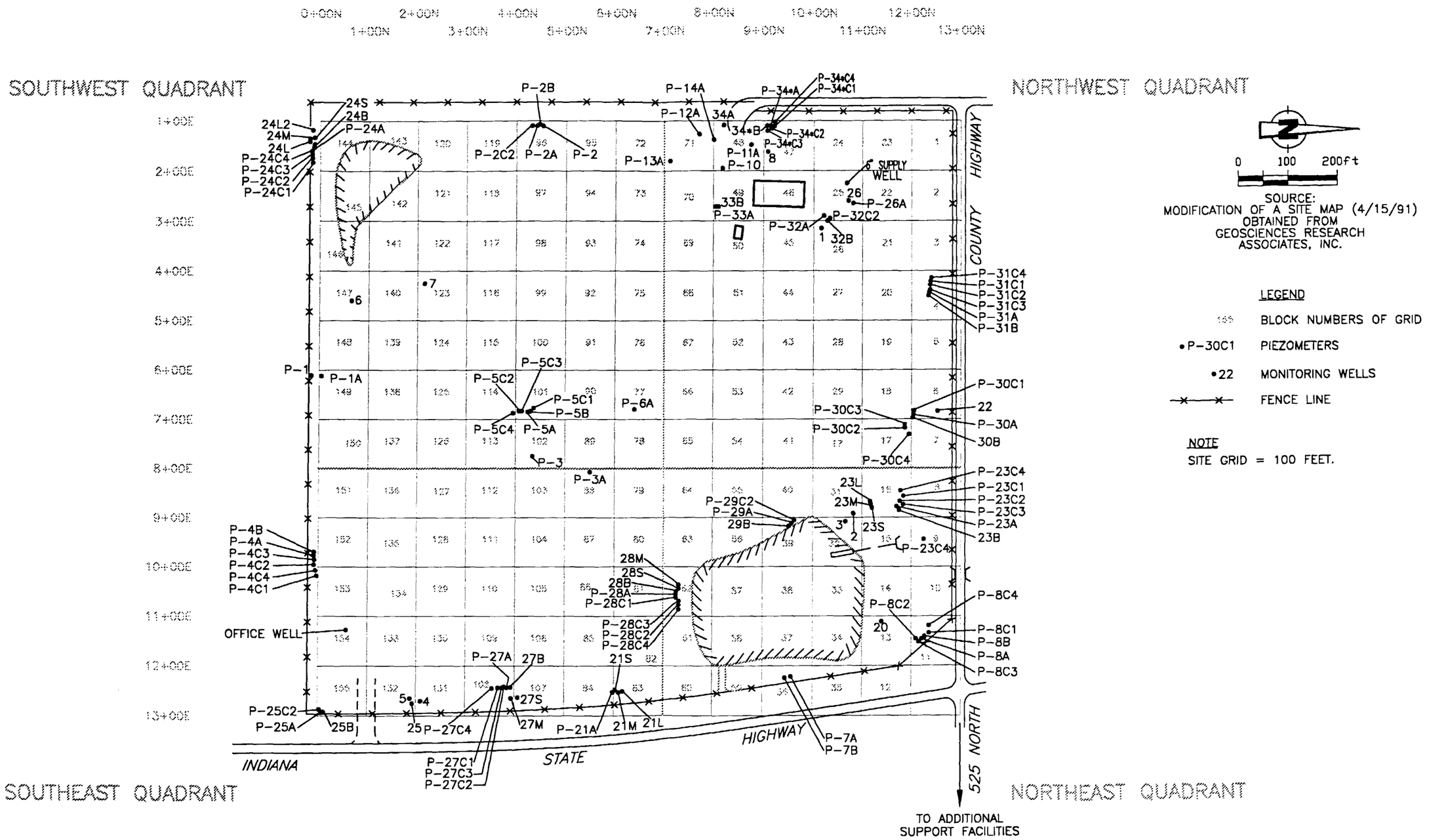

figure 5.1

MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

TASK DESCRIPTION	RI/FS SCHEDULE (MONTHS)																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I RI/FS WORK PLAN																		
IDEM/USEPA APPROVAL	*																	
II SITE CHARACTERIZATION ACTIVITIES																		
A. PREPARATION AND MOBILIZATION	—																	
B. SITE/MONITORING WELL INSPECTIONS		—																
C. GROUNDWATER, SURFACE WATER AND SEDIMENT SAMPLING AND ANALYSIS		—	—	—	—													
D. AIR SCREENING AND ANALYSIS			—	—	—													
E. BASELINE RISK ASSESSMENT/ENVIRONMENTAL EVALUATION			—	—	—	—												
F. MONITORING WELL/PIEZOMETER ABANDONMENTS					—	—												
III SITE MAINTENANCE AND STABILIZATION ACTIVITIES																		
IV SUBMITTALS																		
A. MONTHLY PROGRESS REPORTS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
B. GROUNDWATER TECHNICAL MEMORANDUM																		
1. DEVELOP MEMORANDUM					—	—	—											
2. IDEM/USEPA REVIEW							*	—	—	—								
C. AAD REPORT																		
1. DEVELOP AAD				—	—	—	*											
2. IDEM/USEPA REVIEW OF AAD							—	—	—									
3. REVISE AND SUBMIT AAD									—	*								
D. ENVIRONMENTAL EVALUATION REPORT																		
1. DEVELOP EER					—	—	*											
2. IDEM/USEPA REVIEW OF EER							—	—	—									
3. REVISE AND SUBMIT EER									—	*								
E. RI REPORT																		
1. DEVELOP RI								—	—	—	*							
2. IDEM/USEPA REVIEW OF RI											—	—	—					
3. REVISE AND SUBMIT RI													—	*				
F. FS REPORT																		
1. DEVELOP FS														—	*			
2. IDEM/USEPA REVIEW OF FS															—	—	—	
3. REVISE AND SUBMIT FS																		*
V FOCUSED LEACHATE EVALUATION/REPORT					—	—	—	*										

* MILESTONE OR DATE OF A SUBMITTAL TO IDEM AND USEPA

figure 13.2

RI/FS SCHEDULE
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
June 21, 1972	"Engineering Report - Proposed Commercial Sanitary Landfill Project"	Joseph L. Tite, P.E.	Avery L. Wilkins
March 13, 1973	Notice to Cease and Desist	Dean K. Stinson, M.D. C.I. Newman Indiana State Board of Health (ISBH)	Avery L. Wilkins
November 11, 1980	Resource Conservation and Recovery Act (RCRA) Part A Permit Application	Environmental Waste Control, Inc. (EWC)	U.S. Environmental Protection Agency (USEPA) Region V
June 23, 1983	"Ground Water Study and Monitoring Well Installation"	Dibakar Sundi and John W. Weaver of Salisbury Engineering, a division of ATEC Associates, Inc. (ATEC)	EWC
January 31, 1984	RCRA Part B Permit Application	EWC	USEPA Region V ISBH
November 1, 1984	"Program Proposal - Ground Water Quality Assessment Plan"	Walter W. Grimes of ATEC	ISBH Division of Land Pollution Control
July 1985	Agreed Order for a Ground Water Assessment Plan (GWAP) - Cause No. N-128	Indiana Environmental Management Board	EWC
August 21, 1985	"Revised Submittal - Ground Water Assessment Plan (GWAP)"	John W. Weaver of ATEC	EWC

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
December 31, 1985	RCRA Part B Permit Application (Revision)	EWC	USEPA Region V
September 24, 1986	National Pollutant Discharge Elimination System (NPDES) Permit No. IN 0048097	Indiana Department of Environmental Management (IDEM) Office of Water Management	EWC
October 21, 1986	Notice of Inadequacy regarding RCRA ground water inspection (Cause No. N-128)	Thomas Russell of IDEM's Enforcement Section	Stephen Shambaugh of EWC
November 7, 1986	"Task 1 - Data Compilation and Review Summary, Regulatory Compliance Evaluation, and Hydrogeological Assessment"	Glenn D. Martin and Richard K. Hosfeld of Dames & Moore	Michael Johnson of Advanced Waste Management, Inc. (AWM)
February 26, 1987	RCRA Part A Permit Application (Revision)	EWC	IDEM
March 24, 1987	King Lake sediment and tissue analysis results from August 1985 (Internal Memorandum)	Nancy A. Maloley of IDEM	John Winters of IDEM
April 24, 1987	"Hydrogeologic Assessment Report" (Draft)	Glenn D. Martin and Richard K. Hosfeld of Dames & Moore	Four County Landfill
May 1987	"Study Plan - A Survey for Contaminants in Selected Biota Near the Four County Landfill"	Donald W. Steffeck of U. S. Fish and Wildlife Service (Bloomington, Indiana Field Office)	USEPA Region V IDEM ISBH Agency for Toxic Substances and Disease Registry (ATSDR)

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
May 1987	"Hazardous Waste Ground-Water Task Force Evaluation of the Four County Landfill, Fulton County, IN"	Joseph J. Fredle of USEPA Region V IDEM	
May 29, 1987	"Addendum I to the Four County Landfill Hydrogeologic Assessment Report" (Draft)	James S. Flickinger, Richard K. Hosfeld, and Jeff Steiner of Dames & Moore	EWC
June 5, 1987	"Geologic Setting of the Four County Landfill, Fulton County, Indiana"	John Bassett of Geosciences Research Associates, Inc. (GRA)	EWC
June 17, 1987	"Hydrogeologic Assessment Report" (Revision)	Dames & Moore	AWM
June 30, 1987	RCRA Part B Permit Application (Revision)	EWC AWM Regional Services Corporation (RSC) Resources Unlimited, Inc. (RUI) George Pendygraft of Baker & Daniels	IDEM
September 30, 1987	"Fact Sheet - Intent to Deny a RCRA Operating Permit"	IDEM USEPA Region V	Public
January 11, 1988	"Geologic Interpretation of the Four County Landfill Area" (Memorandum Report)	John Bassett of GRA	Richard J. Wigh of RSC

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
January 12, 1988	"Hydrogeologic Assessment Report" (Final)	Richard K. Hosfeld and Fred W. Erdmann of Dames & Moore	Stephen Shambaugh of EWC
January 18, 1988	Comments and Supplemental Information for the RCRA Part B Permit Application	EWC AWM RSC RUI George Pendygraft of Baker & Daniels	IDEM
January 27, 1988	"Comprehensive Monitoring Evaluation" (CME)	Dean Geers and Chris Williams of Jacobs Engineering Group Inc.	USEPA Region V IDEM
April 1988	"Site Analysis - Four County Landfill, Fulton, Indiana"	Douglas J. Norton of USEPA's Environmental Monitoring Systems Laboratory	USEPA Region V
June 1, 1988	"Groundwater Monitoring Plan"	EWC RSC AWM	Robert Autio of IDEM's Geology Section
October 1988	"A Survey for Contaminants in Selected Biota Near the Four County Landfill, Fulton County, Indiana"	Donald W. Steffeck of the U.S. Fish and Wildlife Service (Bloomington, Indiana Field Office)	ATSDR
November 1988	"Assessment of the Geology, Ground- Water Flow, and Ground-Water Quality at Four County Landfill, Fulton County, Indiana"	Theodore K. Greeman of the U.S. Geological Survey	ATSDR

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
November 28, 1988	"Groundwater Flow Patterns Near the Four County Landfill - A Preliminary Assessment"	Henk Haitjema of Haitjema Consulting, Inc.	Supporters to Oppose Pollution (STOP)
November 30, 1988	"Ambient Air Measurements at Four County Landfill"	Robert B. Jacko	George Pendygraft of Baker & Daniels
March 1989	Judicial Decree for a RCRA Facility Investigation (RFI) Corrective Action Plan (CAP)	U.S. District Court USEPA	EWC
April 13, 1989	"Closure and Post-Closure Plans"	RSC	USEPA Region V IDEM
April 28, 1989	"Implementation of Ground Water Monitoring Plan at EWC Four County Landfill" (Memorandum Report regarding 1988 and 1989 investigations)	John Bassett of GRA	George Pendygraft of Pendygraft & Plews
September 1989	"CAP Task I - Description of Current Conditions" (Draft)	GRA EWC	IDEM USEPA Region V
November 15, 1989	"Work Plan for Soil Boring and Piezometer Installation-Phase II, Interim Corrective Measure Investigation"	GRA EWC	Jonathan Adenuga of USEPA Region V
November 15, 1989	"Health and Safety Plan - Phase II"	AWM EWC	Jonathan Adenuga of USEPA Region V

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
December 7, 1989	"CAP Task I - Description of Current Conditions" (Final)	GRA EWC	IDEM USEPA Region V
December 15, 1989	"P-34A Corrective Measure Investigation" (Memorandum Report)	John Bassett of GRA	Stephen Shambaugh of EWC
December 21, 1989	"Piezometer 34A Subsurface Exploration" (Final Report)	Michael Johnson of AWM Steve Cecil of EWC	IDEM USEPA Region V
January 24, 1990	"Four County Landfill Analysis of Primary Liner Condition for Cells A-North, A-South, B, and C" (Internal Memorandum)	Stephen Pekera of IDEM Engineering Section	Dennis Zawodni of IDEM Enforcement Section
January 31, 1990	"RFI of Corrective Actions - CAP Task VI (Parts A, B, and C)"	WW Engineering & Science Steve Cecil of EWC	USEPA Region V
March 1, 1990	"1989 Annual Groundwater Report"	RSC	USEPA Region V IDEM
April 12, 1990	"GWAP" (Revised from a September 1989 version)	Richard J. Wigh of RSC Stephen Shambaugh of EWC	IDEM USEPA Region V
April 13, 1990 to July 19, 1991	Progress Reports - CAP Task V(B) and Task VIII	Steve Cecil of EWC	Jonathan Adenuga of USEPA Region V, RCRA Enforcement Branch
July 26, 1990	"Final Health Assessment for Four County Landfill"	Louise Fabinski, Joseph L. Hughart, and Kenneth Orloff of the ATSDR	Public Request from Senators Lugar and Quayle

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
October 10, 1990	GWAP Modifications (letter revision of 4/12/90 version)	Kathy Prosser of IDEM	Stephen Shambaugh of EWC
October 12, 1990	"Four County Landfill Fact Sheet," Document Number 00150573	Katten, Muchin & Zavis, Special Environmental Counsel	EWC bankruptcy estate
December 17, 1990	"Four County Landfill Detailed Preliminary Waste-In"	Unknown	Unknown
March 11, 1991	"RFI Work Plan - CAP Task II," including a Project Management Plan, a QAPP, a Data Management Plan, a Health and Safety Plan, a Community Relations Plan, and an Airborne Contamination Work Plan and QAPP	WW Engineering & Science EWC	IDEM USEPA Region V
February 14, 1992	Special Notice Letter, Draft Agreed Order for a RI/FS, and Draft Statement of Work	IDEM	Participating Respondents
April 21, 1992	Good Faith Offer letter and Technical Memorandum	Four County Landfill Site Steering Committee and Technical Committee Environmental Resources Management-North Central, Inc. (ERM-North Central)	Catherine Daugherty and Paul Courtney of IDEM

TABLE 2.1

LIST OF SUBSTANTIVE DOCUMENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Title/Reference*	*Prepared by/Submitted by*	*Prepared for*
August 26, 1993	"Site Background Summary and Detailed Scope of Work Four County Landfill Site, Fulton County, Indiana"	ERM North Central, Inc.	Four County Landfill Technical Committee

TABLE 3.1

SOIL CHARACTERISTICS OF THE UNIT A TILL SEQUENCE [1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Boring Identification	*Sample Depth (feet bgs)*	*Dry Density (pcf)*	*Natural Water Content (percent)*	*Permeability (cm/sec)*	*USDA Classification*	*Unified Soil Classification* [3]
P-1	8 - 10	124.2	15.8	9.6×10^{-8}	Loam [4]	CL/ML [4]
P-1	24 - 26	136.7	10.6	9.6×10^{-8}	Silty clay [4]	CL [4]
P-2	26 - 28	127.1	15.1	2.4×10^{-8}	Silty clay [4]	CL [4]
MW-25	8 - 10	122.5	18.7	1.3×10^{-7}	Loam [4]	CL [4]
MW-25	32 - 34	132.1	17	6.2×10^{-8}	Silty clay [4]	CL [4]
MW-26	8 - 10	132.3	14.7	1.2×10^{-6}	Clay loam [4]	ML [4]
MW-26	28 - 30	128.5	16.3	1.3×10^{-7}	Clay loam [4]	CL/ML [4]
MW-24S	6 - 8	138.3	12.8	7.0×10^{-7}	Sandy loam	SM
MW-28S	24 - 26	127.0	14.6	2.3×10^{-7}	Silty clay loam	ML
MW-28S	30 - 32	127.7	12.8	7.3×10^{-6}	Silt loam	CL/ML
MW-28S	43 - 45	131.4	11.1	1.3×10^{-5}	Silt loam	CL/ML

1 Modified from Table 3 of the January 12, 1988 "Hydrogeologic Assessment Report" by Dames & Moore. Raw data collected between 1986 and 1987.

2 Falling head permeability tests performed on Shelby tube soil samples.

3 Unified Soil Classification designations are as follows:
CL = Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays;
ML = Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity; and
SM = Silty sands, sand-silt mixtures.

4 Based on visual inspection.

Key:

bgs =	Below ground surface
pcf =	Pounds per cubic foot
USDA =	U. S. Department of Agriculture

TABLE 3.2

SOIL CHARACTERIZATION DATA FROM 1988 AND 1989 INVESTIGATIONS[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

			Texture (Percent Finer)								Atterberg Limits			Soil Classification	
			Sieve					Hydrometer							
Stratigraphic Unit Sampled[2]	Boring Identification	Sample Depth (feet bgs)	#4, 4.75 (mm)	#10, 2.00 (mm)	#35, 0.50 (mm)	#120, 0.125 (mm)	#200, 0.074 (mm)	0.050 (mm)	0.005 (mm)	0.002 (mm)	LL (percent)	PL (percent)	PI	USDA	Unified[3]
Subunit A1	24 B	10.0 - 12.0	97.7	92.0	86.6	71.8	66.7	62.0	27.0	19.5	24.5	14.2	10.3	Loam	CL
	28 B	22.0 - 25.5	95.5	89.7	80.2	65.0	60.4	54.5	22.0	14.9	25.5	15.4	10.1	Loam	CL
	32 B	12.0 - 14.0	96.3	92.0	85.2	66.2	60.3	54.0	22.0	14.5	21.8	13.9	7.9	Loam	CL
Subunit A2	24 B	17.2 - 20.0	100.0	96.5	93.6	88.8	85.8	81.5	37.0	24.0	26.7	16.6	10.1	Silt loam	CL
	25 A	10.0 - 12.0	97.4	94.7	90.9	83.8	79.5	75.5	30.5	19.9	26.0	16.4	9.6	Silt loam	CL
	28 B	28.0 - 30.0	99.2	96.7	93.3	87.8	84.1	78.0	32.5	22.0	24.2	15.4	8.8	Silt loam	CL
	32 B	20.0 - 22.0	98.7	97.0	93.6	86.9	83.3	78.0	34.5	22.5	26.8	15.7	11.1	Silt loam	CL
Subunit A22	24 B	22.0 - 24.0	97.3	91.8	84.4	62.8	57.3	52.5	25.0	15.5	23.9	14.3	9.6	Loam	CL
	25 A	22.0 - 24.0	94.6	89.6	81.2	58.9	52.8	49.5	19.5	14.0	17.6	13.0	4.7	Loam	CL-ML
	28 B	36.0 - 38.0	92.8	88.4	81.4	61.6	55.3	50.5	19.5	13.0	20.2	12.9	7.3	Loam	CL
	32 B	30.0 - 32.0	90.8	86.0	78.6	56.3	50.1	45.0	18.5	12.0	17.5	11.9	5.6	Loam	CL-ML
Subunit A3	24 B	46.0 - 48.0	97.6	94.2	91.5	85.5	83.1	79.0	28.5	18.0	24.9	16.0	9.0	Silt loam	CL
	25 A	34.0 - 36.0	98.8	95.6	91.4	72.5	65.4	61.0	21.0	13.0	18.7	12.7	6.0	Silt loam	CL-ML
	28 B	46.0 - 48.0	97.4	93.6	89.5	72.0	65.3	59.0	20.0	12.0	19.3	12.8	6.5	Silt loam	CL-ML
	32 B	40.0 - 41.5	98.2	95.7	91.9	75.7	68.6	63.0	21.0	13.0	19.4	13.5	5.8	Silt loam	CL-ML
Unit B	5 B	48.0 - 50.0	100.0	100.0	100.0	25.9	11.4	6.0	1.0	1.0	Nonplastic			Sand	SP-SM
	8 C3	71.0 - 73.0	100.0	100.0	99.4	98.2	96.3	90.0	6.5	2.5	Nonplastic			Silt	ML
	23 B	26.0 - 28.0	85.6	78.7	67.2	42.4	37.3	32.0	9.9	6.5	Nonplastic			Gv sandy loam	SM
	23 C3	48.0 - 50.0	99.9	99.9	99.9	97.2	80.2	68.5	11.0	4.0	Nonplastic			Silt loam	ML
	28 B	52.0 - 54.0	85.9	91.6	71.1	22.1	18.3	13.9	5.8	3.5	Nonplastic			Loamy sand	SM
Upper Unit C	5 C1	75.0 - 77.0	100.0	99.9	90.9	12.4	10.0	8.4	3.3	1.9	Nonplastic			Sand	SP-SM
	5 C1	65.0 - 67.0	100.0	99.9	99.9	20.7	11.5	7.5	2.5	1.8	Nonplastic			Sand	SW-SM
	28 C3	95.0 - 97.0	99.8	98.7	96.7	21.6	16.6	11.5	4.0	3.0	Nonplastic			Sand	SM
	28 C3	110.0 - 112.0	98.0	95.3	89.6	31.5	18.1	12.5	2.5	1.5	Nonplastic			Loamy sand	SM
Subunit C2	4 C3	115.0 - 117.0	63.0	47.1	24.9	14.0	12.0	10.0	3.5	2.5	Nonplastic			V gv loamy sand	SW-SM
	5 C3	83.0 - 85.0	94.2	79.0	40.8	13.0	10.0	8.0	2.4	1.6	Nonplastic			Gv sand	SW-SM
	23 C3	115.0 - 117.0	99.1	97.8	42.2	11.4	9.8	8.0	2.9	2.0	Nonplastic			Sand	SW-SM
	25 C2	115.0 - 117.0	80.3	57.0	22.8	8.0	6.0	4.5	3.0	1.9	Nonplastic			Gv sand	SW-SM
	28 C3	120.0 - 122.0	78.9	60.8	28.9	14.5	12.1	10.0	2.9	2.0	Nonplastic			Gv loamy sand	SM
	31 C2	115.0 - 116.5	70.8	48.4	29.1	19.2	17.8	12.0	2.5	2.0	Nonplastic			V gv loamy sand	SM

TABLE 3.2

SOIL CHARACTERIZATION DATA FROM 1988 AND 1989 INVESTIGATIONS[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

			Texture (Percent Finer)								Atterberg Limits			Soil Classification	
			Sieve					Hydrometer							
Stratigraphic Unit Sampled[2]	Boring Identification	Sample Depth (feet bgs)	#4, 4.75 (mm)	#10, 2.00 (mm)	#35, 0.50 (mm)	#120, 0.125 (mm)	#200, 0.074 (mm)	0.050 (mm)	0.005 (mm)	0.002 (mm)	LL (percent)	PL (percent)	PI	USDA	Unified[3]
Unit C Muddy Zone	5 C3	113.0 - 115.0	100.0	100.0	99.7	98.0	87.5	74.0	17.3	10.9	25.3	15.0	10.3	Silt loam	CL
Unit C Diamict Zone	30 C3	110.0 - 111.5	100.0	99.8	98.9	93.1	89.3	84.5	43.0	26.5	31.2	15.8	15.4	Silt loam	CL
Lower Unit C	8 C3	131.0 - 133.0	82.2	67.6	42.4	13.4	10.5	8.9	2.8	1.9		Nonplastic		Gv sand	SW-SM
	23 C3	135.0 - 137.0	96.7	85.2	69.7	11.3	8.9	7.5	2.0	2.0		Nonplastic		Sand	SP-SM
	28 C3	130.0 - 132.0	100.0	99.6	86.1	15.1	11.5	9.0	2.5	1.8		Nonplastic		Sand	SP-SM

1 Modified from Table 1 of the April 28, 1989 Memorandum Report by Geosciences Research Associates, Inc. regarding the 1988 and 1989 investigations.

2 Stratigraphic units are defined as follows:
A = Glacial till sequence, silty clay loam with silt and sand seams;
B = Glacio-lacustrine sequence, silt and fine- to medium-grained sand;
C = Glacio-fluvial sequence, poorly sorted silt, sand, and gravel; and
D = Basal till, silty clay with reddish hue at base.

3 Unified Soil Classification designations are as follows:
CL = Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays;
ML = Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity;
SM = Silty sands, sand-silt mixtures;
SP = Poorly graded sands, gravelly sands with little or no fines; and
SW = Well graded, gravelly sands with little or no fines.

Key:

bgs	=	Below ground surface
Gv	=	Gravelly
LL	=	Liquid limit
PI	=	Plasticity index
PL	=	Plastic limit
USDA	=	U.S. Department of Agriculture
V	=	Very

TABLE 3.3

CATION EXCHANGE CAPACITY AND CALCIUM CARBONATE EQUIVALENCY DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Stratigraphic Unit Sampled[2]	*Boring Identification*	*Sample Depth (feet bgs)*	*CEC (meq/100 g)*	*CCE (percent $CaCO_3$ equivalents)*
Subunit A1	24B	10.0-12.0	4.6	26.8
	28B	22.0-25.5	3.6	24.3
	32B	12.0-14.0	5.2	27.2
Subunit A2	24B	17.2-20.0	2.3	24.6
	25A	10.0-12.0	5.7	24.3
	28B	28.0-30.0	5.3	24.5
	32B	20.0-22.0	3.8	23.8
Subunit A22	24B	22.0-24.0	2.3	18.8
	25A	22.0-24.0	2.7	20.6
	28B	36.0-38.0	2.6	21.8
	32B	30.0-32.0	3.9	21.9
Subunit A3	24B	46.8-48.0	4.3	28.8
	25A	34.0-36.0	5.9	23.9
	28B	46.0-48.0	3.2	24.4
	29B	36.0-37.2	–	28.8
	29B	37.2-38.2	–	24.8
	32B	40.0-41.5	3.0	24.1

[1] Modified from Table 2 of the April 28, 1989 Memorandum Report by Geosciences Research Associates, Inc. regarding 1988 and 1989 investigations.

[2] A detailed description of the Unit A glacial till (including subunits) is provided in the April 28, 1989 Memorandum Report prepared by John Bassett of Geosciences Research Associates, Inc.

Key:

bgs = Below ground surface
$CaCo_3$ = Calcium carbonate
CCE = Calcium carbonate equivalency
CEC = Cation exchange capacity
meq = Milliequivalents
– = No data reported
g = grams

TABLE 3.4

SUMMARY OF WELL LOCATIONS [1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Northwest Quadrant

Monitoring Wells = 9
Piezometers = 24

MW-1	P-30C1
MW-8	P-30C2
MW-22	P-30C3
MW-26	P-30C4
MW-30B	P-32A
MW-31B	P-32C2
MW-32B	P-31A
MW-33B	P-31C1
MW-34*B	P-31C2
P-10	P-31C3
P-11A	P-31C4
P-12A	P-34*A [2]
P-13A	P-34*C1
P-14A	P-34*C2
P-26A	P-34*C3
P-33A	P-34*C4
P-30A	6" Diameter Supply Well
P-34A Sump	

Northeast Quadrant

Monitoring Wells = 11
Piezometers = 20

MW-2	P-8B
MW-3	P-8C1
MW-20	P-8C2
MW-23S	P-8C3
MW-23M	P-8C4
MW-23B	P-23A
MW-23L	P-23C1
MW-28S	P-23C2
MW-28B	P-23C3
MW-28M	P-23C4
MW-29B	P-28A
P-7A	P-28C1
P-7B	P-28C2
P-29A	P-28C3
P-29C2	P-28C4
P-8A	

Southwest Quadrant

Monitoring Wells = 7
Piezometers = 19

MW-6	P-2B
MW-7	P-2C2
MW-24S	P-5A
MW-24M	P-5B
MW-24B	P-5C1
MW-24L	P-5C2
MW-24L2	P-5C3
P-1A	P-5C4
P-1	P-24A
P-3	P-24C1
P-6A	P-24C2
P-2	P-24C3
P-2A	P-24C4

Southeast Quadrant

Monitoring Wells = 10
Piezometers = 15

MW-4	P-25C2
MW-5	P-4A
MW-21S	P-4B
MW-21M	P-4C1
MW-21L	P-4C2
MW-25	P-4C3
MW-25B	P-4C4
MW-27S	P-27A
MW-27M	P-27C1
MW-27B	P-27C2
P-3A	P-27C3
P-21A	P-27C4
P-25A	

Former Support Facilities (Trailer) Supply Well

TOTALS:	
Piezometers	78
Monitoring Wells	37
Water Supply Wells	2
Sumps	1
	118

[1] All wells known to have been installed are listed, although some may have been damaged or abandoned.

[2] A piezometer/monitoring well cluster with a numeric designation of "34*" was installed by Geosciences Research Associates between December 1988 and January 1989. The asterisk (*) is not a footnote, but rather a means of distinguishing this cluster from P-34A, also located in the northwest quadrant.

TABLE 3.5

SUMMARY OF HYDRAULIC CONDUCTIVITY DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Identification	*Well Screen Interval (feet bgs)*	*Slug Test Analytical Method*		*Laboratory Analysis*[2] *(cm/sec)*
		Hvorslev (cm/sec)	*Papadopulos (cm/sec)*	
MW-21S	45 - 60	1.42 x 10-5	1.20 x 10-4	3.5 x 10-5
MW-21M	85 - 95	1.00 x 10-4	2.40 x 10-4	4.3 x 10-3
MW-21L	202 - 212	6.00 x 10-6	1.54 x 10-5	2.6 x 10-5
MW-25	64 - 74	1.37 x 10-4	3	--
MW-26	67 - 77	1.06 x 10-5	4.20 x 10-5	--

[1] Modified from Table 7 of Dames & Moore's "Hydrogeologic Assessment Report" dated January 12, 1988.
[2] Falling head permeability tests were performed on reconstituted or remolded samples.
[3] No type curve match was possible.

Key:

bgs = Below ground surface
-- = No data reported

TABLE 4.1

WASTE CLASSIFICATION SUMMARY [1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

General Waste Type	*Years Deposited*		*Volume (cubic yards)*
General Refuse	1972 through 1985		65,000.00
Special Waste (Separate Area Waste)	1978		2,764.22
	1979		25,849.36
	1980		22,872.51
		Subtotal	51,486.09
RCRA Hazardous Waste	1980		1,631.80
	1981		22,862.23
	1982		11,898.70
	1983		15,592.94
	1984		11,693.84
	1985		31,725.09
	1986		16,066.39
	1987		72,739.96
	1988		156,656.57
	1989 (January - March)		44,381.52
		Subtotal	385,249.04
		TOTAL	501,735.13

[1] Modified from Table C-2 of RSC's April 13, 1989 "Closure and Post-Closure Plans." Not intended to be a complete or detailed listing.

TABLE 4.2
SUMMARY OF WASTE TYPES AND DESCRIPTIONS[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Waste Type	*Waste Description (Appendix VII Constituents)*
D004	Arsenic
D005	Barium
D006	Cadmium
D007	Chromium
D008	Lead
D009	Mercury
D010	Selenium
F006	Wastewater treatment sludge from electroplating (Cd, Cr^{6+}, Ni, CN^-)
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments (Cr^{6+}, Pb)
K003	Wastewater treatment sludge from the production of molybdate orange pigments (Cr^{6+}, Pb)
K004	Wastewater treatment sludge from the production of zinc yellow pigments (Cr^{6+})
K005	Wastewater treatment sludge from the production of chrome green pigments (Cr^{6+}, Pb)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (Cr^{6+})
K008	Oven residue from production of chrome oxide green pigments (Cr^{6+})
K046	Wastewater treatment sludge from the manufacture, formulation, and loading of lead-based initiating compounds (Pb)
K048	Dissolved air floatation (DAF) debris from the petroleum refining industry (Cr^{6+}, Pb)
K049	Slop oil emulsion solids from the petroleum refining industry (Cr^{6+}, Pb)
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry (Cr^{6+})
K051	API separator sludge from the petroleum refining industry (Cr^{6+}, Pb)
K052	Tank bottoms (leaded) from the petroleum refining industry (Pb)
K061	Emission control dust/sludge from the primary production of steel in electric furnaces (Cr^{6+}, Pb, Cd)
K069	Emission control dust/sludge from secondary lead smelting (Cr^{6+}, Pb, Cd)
D002	Corrosive [high pH only (> 12.5)]

[1] Modified from the text of Jacobs Engineering Inc.'s January 27, 1988 "Comprehensive Monitoring Evaluation." Original source was a February 26, 1987 RCRA Part A Permit Application submitted by Environmental Waste Control, Inc. Not intended to be a complete or detailed listing.

TABLE 6.1

POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location	*Requirement*	*Citation*
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	40 CFR 264.18(b); 329 IAC 3.1[2]
Within floodplain	Action must avoid adverse effects, minimize potential harm, and if necessary, restore and preserve natural and beneficial values of the floodplain.	Executive Order 11988, Floodplain Management, (40 CFR 6, Appendix A)
Within floodplain in Indiana	Action must avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the floodplain. Construction of abodes or residences is prohibited and prior approval of the IDNR is required for other types of construction, excavation, or filling in or on a floodway. This includes but is not limited to construction of a fence, water treatment facility, dredging, and/or dewatering in a floodway.	Indiana Flood Control Act (13-2-22)
Wetland	Action must minimize the destruction, loss, or degradation of wetlands. Discharge of dredged or fill material into wetlands without permit is prohibited.	Executive Order 11990, Protection of Wetlands, (40 CFR 6, Appendix A) Clean Water Act, Section 404; 40 CFR Parts 230, 231
Critical habitat upon which endangered species or threatened species depends	Action to conserve endangered species or threatened species, including consultation with the Department of Interior	Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR Part 200, 50 CFR Part 402 Fish and Wildlife Coordination Act (16 USC 661 et seq.); 33 CFR Parts 320-330.

Notes:

[1]Modified from Exhibit 1-2 of USEPA's Draft Guidance CERCLA Compliance With Other Laws (August 1988).

[2]As of February 1992, Indiana adopted new hazardous waste rules titled 329 IAC 3.1, which adopt by reference the Code of Federal Regulations (40 CFR 260 through 270). The State rules generally only cover the administrative procedures while the federal rules cover the standards for RCRA generators and treatment, storage, and disposal facilities.

TABLE 6.2

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Air stripping	Design system to provide odor-free operation.	CAA Section 101[2]
	Total organic emissions from air strippers be reduced below 1.4 kg/hour or 2.8 mg/year (3 pounds/hr. or 3.1 tons/year); or that organic emissions be reduced 95 percent by weig	40 CFR 264 AA
	File an Air Pollution Emission Notice (APEN) with the State of Indiana to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2-1-2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm.	40 CFR 61; 326 IAC 14
	Follow RCRA generator standards for manifesting, handling, record keeping, and accumulation times for waste water, if determined to be hazardous.	40 CFR 262.10-262.44; 329 IAC 3.1-7[3]
	Treatment of waste water contained in tanks over 90 days would require facility to meet TSD standards.	See Treatment (in a unit), and Tank Storage (on site) in this table.
Capping	Placement of a cap over a landfill requires a cover designed and constructed to:	40 CFR 264.310(a); 329 IAC 3.1[3]
	Provide long-term minimization of infiltration of liquids through the capped area. Function with minimum maintenance. Promote drainage and minimize erosion or abrasion of the cover. Accommodate settling and subsidence so that the cover's integrity is maintained. Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	
	Restrict post-closure use of property as necessary to prevent damage to the cover.	40 CFR 264.117(c); 329 IAC 3.1[3]
	Prevent run-on and run-off from damaging cover.	40 CFR 264.310(b); 329 IAC 3.1[3]
	Protect and maintain surveyed benchmarks used to locate waste cells.	40 CFR 264.310(b); 329 IAC 3.1[3]
	Disposal or decontamination of equipment, structures, and soils.	40 CFR 264.114; 329 IAC 3.1[3]

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Construction Activity	Stormwater runoff associated with construction activity.	327 IAC 15-5
Closure with waste in place (capping)	Installation of final cover to provide long-term minimization of infiltration.	40 CFR 264.310; 329 IAC 3.1[3]
	Stabilize wastes, if necessary, to support cover.	40 CFR 264.228; 40 CFR 264.258
	Post-closure care and ground water monitoring.	40 CFR 264.310; 329 IAC 3.1[3]
Direct discharge of treatment system effluent	Applicable federal water quality criteria for the protection of aquatic life must be complied with when environmental factors are being considered.	50 CFR 30784
	Applicable federally approved state water quality standards must be complied with. These standards may be in addition to or more stringent than other federal standards under the CWA.	40 CFR 122.44 and state regulations approved under 40 CFR 131; 327 IAC 5-2-10; 327 IAC 2
	The discharge must be consistent with the requirement of a Water Quality Management Plan approved by EPA under Section 208(b) of the Clean Water Act.	CWA Section 208(b); 327 IAC 5-2-10(e)[4]
	Use of best available technology (BAT) economically achievable is required to control toxic and nonconventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis. In some cases, the permit limit for a conventional pollutant may be more stringent than BCT.	40 CFR 122.44(a) 327 IAC 5-5-2
	Discharge limitations must be established for all toxic pollutants that are or may be discharged at levels greater than those that can be achieved by technology-based standards.	40 CFR 122.44(e)
	Discharge must be monitored to assure compliance. Discharger will monitor: The mass of each pollutant discharged; The volume of effluent discharged; and Frequency of discharge and other measurements as appropriate.	40 CFR 122.44(i); 327 IAC 5-2-13

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Direct discharge of treatment system effluent (continued)	The following records must be maintained: Date, place, and time of measurements; Person(s) who performed sampling or measurement; Date(s) analyses were performed; Person(s) who performed analyses; Analytical techniques or methods used; and Results for measurements and analyses.	327 IAC 5-2-14; 40 CFR 122.44(i); 327 IAC 5-2-15
	The discharge monitoring reports (DMRs) must be submitted to IDEM as required by the permit (at least annually).	
	Approved test methods for waste constituents to be monitored must be followed. Detailed requirements for analytical procedures and quality controls are provided.	40 CFR 122.44(i); 40 CFR 136; 327 IAC 5-2-13(c)
	Permit application information must be submitted, including a description of activities, listing of environmental permits, etc.	40 CFR 122.21
	Comply with additional permit conditions such as:	40 CFR 122.41(i); 327 IAC 5-2-8
	Duty to mitigate any adverse effects of any discharge; Report to IDEM violations of maximum daily discharge for certain pollutants within 24 hours; and Proper operation and maintenance of treatment systems.	
	Develop and implement a Best Management Practices (BMP) program and incorporate in the NPDES permit to prevent the release of toxic constituents to surface waters.	40 CFR 125.100; 327 IAC 5-9

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Direct discharge of treatment system effluent (continued)	The BMP program must:	40 CFR 125.104
	Establish specific procedures for the control of toxic and hazardous pollutant spills; Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a reasonable potential for equipment failure; and Prescribe sample preservation procedures, container materials, and maximum allowable holding times.	40 CFR 136.1-136.4; 327 IAC 5-2-13(c)
Discharge to POTW	Pollutants that pass through the POTW without treatment, interfere with POTW operation, or contaminate POTW sludge are prohibited.	40 CFR 403.5; 327 IAC 5-11-1
	Specific prohibitions preclude the discharge of pollutants to POTWs that: Create a fire or explosion hazard in the POTW; Are corrosive (pH<5.0); Obstruct flow resulting in interference; Are discharged at a flow rate and/or concentration that will result in interference; and/or Increase the temperature of wastewater entering the treatment plant that would result in interference, or raise the POTW influent temperature above 104°F (40°C).	40 CFR 403.5; 327 IAC 5-12-2(b)
	Discharge must comply with local POTW pretreatment program, including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements.	40 CFR 403.5 and local POTW regulations
	RCRA permit-by-rule requirements may be applicable to discharges of RCRA hazardous wastes to POTWs by truck, rail, or dedicated pipe.	40 CFR 264.71; 40 CFR 264.72; 40 CFR 262; 40 CFR 270.60(C); 40 CFR 264.1; 40 CFR 261.3(A)(2)(IV); CWA Section 402 or 307(b); 329 IAC 3.1-7[3]
Gas collection	Meet Clean Air Act requirements, and meet state ambient air quality standards.	CAA; 326 IAC 1-3

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Gas collection (continued)	Design system to provide odor-free operation.	CAA Section 101[2]; 40 CFR 52[2]
	Establish procedures for review of construction and operation of any source that has the potential to emit criteria air pollutants. File an Air Pollution Emission Notice (APEN) with state to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm.	40 CFR 61[2]; 326 IAC 14
	Meet established limits for VOC emissions. Best Available Control Technology (BACT) is required if emissions exceed 25 tons/year.	326 IAC 8-1
Operation and maintenance (O&M)	Post-closure care to ensure that site is maintained and monitored.	40 CFR 264.118 (RCRA Subpart G); 329 IAC 3.1[3]
	Develop Contingency Plan and Emergency Procedures to minimize potential hazards from fires, explosions or any unplanned release during closure and post-closure status.	40 CFR 264 (Subpart D)
Security	Sites should be secured in accordance with this rule which: 1) Requires prevention of unknowing and unauthorized entry of persons or livestock if physical contact with the waste, etc. could cause injury or, if disturbance of the waste, etc. would cause a violation. 2) The facility must have either: A 24 hour surveillance system which continuously monitors and controls entry or an artificial or natural barrier which completely surrounds the active portion and a means to control entry (i.e., a lock) at all times, through the gates or other entrances to the active portion. 3) "Danger - Unauthorized Personnel Keep Out" signs are required at each entrance and other locations sufficient to be seen from any approach, legible from a distance of at least 25 feet.	40 CFR 264 (Subpart C)
Slurry wall	Excavation of soil for construction of slurry wall may trigger cleanup or land disposal restrictions.	See Consolidation, Excavation in this table.

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Surface water control	Prevent run-on, and control and collect runoff from a 24-hour, 25-year storm during closure and post-closure status.	40 CFR 264.301(f)(g)(h); 329 IAC 3.1[3]
Tank storage (on-site)[4]	Ensure tanks have sufficient structural strength that they do not collapse, rupture, or fail.	40 CFR 264.190
	Ensure waste is not incompatible with the tank material unless the tank is protected by a liner or by other means.	40 CFR 264.191
	Provide tanks with secondary containment and controls to prevent overfilling, and maintain sufficient freeboard in open tanks to prevent overtopping by wave action or precipitation.	40 CFR 264.193-194
	Inspect the following: overfilling control, control equipment, monitoring data, waste level (for uncovered tanks), tank condition, above-ground portions of tanks (to assess their structural integrity), and the area surrounding the tank (to identify signs of leakage).	40 CFR 264.195
	Repair any corrosion, crack, or leak.	40 CFR 264.196
	At closure, remove all hazardous waste and hazardous waste residues from tanks, discharge control equipment, and discharge confinement structures.	40 CFR 264.197
	Storage of banned wastes must be in accordance with 40 CFR 268. When such storage occurs beyond one year, the owner/operator bears the burden of proving that such storage is solely for the purpose of accumulating sufficient quantities to allow for proper recovery, treatment and disposal.	40 CFR 268.50

TABLE 6.2

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Treatment	Standards for miscellaneous units (long-term retrievable storage, thermal treatment other than incineration, open burning, open detonation, chemical, physical, and biological treatment units other than tanks, surface impoundments, or land treatment units) require new miscellaneous units to satisfy environmental performance standards by protection of ground water, surface water, and air quality, and by limiting surface and subsurface migration.	40 CFR 264 (Subpart X); 329 IAC 3.1[3]
	Requires permit for construction of treatment facility and specifies standards for facility.	327 IAC 3
	Treatment of wastes subject to ban on land disposal must attain levels achievable by best demonstrated available treatment technologies (BDAT) for each hazardous constituent in each listed waste.	40 CFR 268 (Subpart D)
	Prepare fugitive and odor emission control plan for this action.	CAA Section 101[2]; 40 CFR 52[2]
	Establish procedures for review of construction and operation of any source that has the potential to emit criteria air pollutants. File an Air Pollution Emission Notice (APEN) with state to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm.	40 CFR 61[2]; 326 IAC 14
Treatment (in a unit)	Meet requirements for design and operating standards for a specified unit in which hazardous waste is treated (see citation).	40 CFR 264.190-264.192 (Tanks) 40 CFR 264.601 (Miscellaneous Treatment Unit)
Excavation	Area from which materials are excavated may require cleanup to levels established by closure requirements.	40 CFR 264 Disposal and Closure Requirements; 329 IAC 3.1[3]
	Movement of wastes beyond the site boundary (i.e., outside the landfilled area) may trigger Land Ban requirements and restrictions.	40 CFR 268

TABLE 6.2

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Excavation (continued)	Removal of non-hazardous excavated material from a CERCLA site may qualify the material as special waste and is subject to state regulations for special waste.	329 IAC 2-21
	All listed and characteristic hazardous wastes or soils and debris contaminated by a RCRA hazardous waste and removed from a CERCLA site may not be land disposed until treated as required by Land Ban. If alternative treatment technologies can achieve treatment similar to that required by Land Ban, and if this achievement can be documented, then a variance may not be required.	40 CFR 268
	Transport and disposal of hazardous waste excavated from a CERCLA site will require state administrative and financial assurance and state manifest.	329 IAC 3.1[2]
	Develop fugitive and odor emission control plan for this action if existing site plan is inadequate.	CAA Section 101[2]; 40 CFR 52[2]
	Particulate emissions from earth moving and material handling activities must be controlled, such that no visible emissions cross the property line and the increase in upward/downward total suspended particulate concentration is limited to 50 $\mu g/m^3$.	326 IAC 6-4
	File an Air Pollution Emission Notice (APEN) with state to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2-1-2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm.	40 CFR 61[2]; 326 IAC 14
Consolidation	Consolidation in storage piles will trigger storage requirements.	40 CFR 262.34; 40 CFR 268 (Subpart E)
	Placement on or in land outside unit boundary or area of contamination will trigger land disposal requirements and restrictions.	40 CFR 285 (Subpart D)
	Movement of wastes beyond the site boundary (i.e., outside the landfilled area) may trigger Land Ban requirements and restrictions.	40 CFR 268

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Consolidation (continued)	Develop fugitive and odor emission control plan for this action if existing site plan is inadequate.	CAA Section 101[2]; 40 CFR 52[2]
	File and Air Pollution Emission Notice (APEN) with state to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2-1-2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm.	40 CFR 61[2]; 326 IAC 14

Notes:

1 Modified from Exhibit 1-3 of USEPA's Draft Guidance CERCLA Compliance With Other Laws (August 1988) and Exhibit 1-3 of CERCLA Compliance With Other Laws, Part II (August 1989).

2 All of the Clean Air Act ARARs that have been established by the Federal government may be covered by matching State regulations. The State may have the authority to manage these programs through the approval of its implementation plans (40 CFR 52 Subpart G).

3 As of February 1992, Indiana adopted new hazardous waste rules titled 329 IAC 3.1, which adopt by reference the federal regulations 40 CFR 260 through 270. Therefore, any reference to these CFR citations implies coverage under the State rules. The State rules generally only cover the administrative procedures while the federal regulations cover the standards for RCRA generators and TSD facilities.

4 Tank storage requirements are for the storage of RCRA hazardous waste. A generator who accumulates or stores hazardous waste on site for 90 days or less in compliance with 40 CFR 262.34(a)(1-4) is not subject to the full RCRA storage requirements.

Key:

CAA = Clean Air Act
CFR = Code of Federal Regulations
CWA = Clean Water Act
IAC = Indiana Administrative Code
TSD = Treatment, Storage, and Disposal

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Piezometer/ Well ID	*Stratigraphic Unit(s) Screened*	*Former/ Other ID* [2]	*Casing Elevation (feet amsl)*	*Site Quadrant* [3]	*Date of Installation*	*Well Depth (feet bgs)/ Bottom Elevation (feet amsl)*	*Screen Length (feet)*	*Sand Pack Length (feet)*	*Well Construction Details* [4]	*Comments*
P-1	B	MW-1B	783.07	SW	12/08/86	65.0/718.1	5	13.0	hand slotted PVC, 1" dia., 3.75" dia. borehole,	
P-1A	A	--	787.64	SW	12/05/88	37.1/749.2	2	2.7	4.25" dia. borehole, 2' bentonite seal, [5]	
P-2	B	--	777.55	SW	12/15/86	80.0/697.9	10	12.0	hand slotted PVC, 1" dia., 7.25" dia. borehole, 8' bentonite seal	
P-2A	A	--	777.38	SW	12/05/88	17.0/758.0	2	2.6	4.25" dia. borehole, 3' bentonite seal, [5]	
P-2B	B	MW-2B	777.05	SW	12/05/88	72.2/702.7	4	6.4	4.25" dia. borehole, 7.8' bentonite seal, [5]	
P-2C2	C	--	776.86	SW	12/09/89	134.9/639.8	2	5.5	4.9" dia. borehole, no bentonite seal, [5]	
P-3	B?	--	772.71	SW	12/10/86	50.9/715.4	5	18.9	hand slotted PVC, 1" dia., 3.75" dia. borehole, 2' bentonite seal	Assume casing removed 12/19/86.
P-3A	A?	--	766.22	SE	unknown	unknown	unknown	unknown	unknown	Assume casing removed during Cell B construction.
P-4A	A	--	790.03	SE	11/07/88	19.0/769.1	2	2.8	4.25" dia. borehole, 2' bentonite seal, [5]	
P-4B	B	--	790.00	SE	11/04/88	69.6/718.6	2	6.4	4.25" dia. borehole, 2.7' bentonite seal, [5]	
P-4C1	C	--	791.02	SE	01/04/89	85.6/703.9	2	4.0	4.9" dia. borehole, no bentonite seal, [5]	
P-4C2	C	--	791.72	SE	01/03/89	132.9/656.7	2	4.0	4.9" dia. borehole, no bentonite seal, [5]	
P-4C3	C	--	791.71	SE	02/02/89	155.6/633.9	2	4.5	4.9" dia. borehole, no bentonite seal, [5]	
P-4C4	C	--	791.02	SE	01/27/89	152.5/637.0	2	4.0	Schedule 80 PVC, 4.9"dia. borehole, no bentonite seal, [5]	
P-5A	A/B?	--	776.93	SW	11/08/88	28.1/746.3	2	4?	4.25" dia. borehole, 2' bentonite seal, [5]	
P-5B	B	MW-5B	776.86	SW	11/03/88	49.1/725.0	2	6.1	4.25" dia. borehole, 2' bentonite seal, [5]	
P-5C1	C	--	776.63	SW	01/12/89	77.1/696.6	2	3.0	4.5" dia. borehole, no bentonite seal, [5]	
P-5C2	C	--	777.29	SW	01/18/89	107.4/666.9	2	4.0	4.9" dia. borehole, 2' bentonite seal, [5]	
P-5C3	C	--	777.05	SW	01/18/89	119.8/654.5	2	2.8	4.25" dia. borehole, 2' bentonite seal, [5]	
P-5C4	C	--	777.23	SW	01/29/89	166.2/608.3	2	5.0	Schedule 80 PVC, 4.9"dia. borehole, no bentonite seal, [5]	

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Piezometer/ Well ID	*Stratigraphic Unit(s) Screened*	*Former/ Other ID* [2]	*Casing Elevation (feet amsl)*	*Site Quadrant* [3]	*Date of Installation*	*Well Depth (feet bgs)/ Bottom Elevation (feet amsl)*	*Screen Length (feet)*	*Sand Pack Length (feet)*	*Well Construction Details* [4]	*Comments*
P-6A	A		776.57	SW	11/01/88	21.0/752.9	2	3.0	4.25" dia. borehole, 2.1' bentonite seal, [6]	
P-7A	B	--	771.24	NE	11/18/88	21.4/748.0	2	2.7	4.25" dia. borehole, 2' bentonite seal, [5]	
P-7B	B	MW-7B	770.92	NE	11/17/88	50.9/718.4	5	6.0	4.25" dia. borehole, 2' bentonite seal, [5]	
P8A	A	--	757.70	NE	11/23/88	19.9/735.4	2	3.9	4.25" dia. borehole, 2' bentonite seal, [5]	
P-8B	B	MW-8B	756.99	NE	11/02/88	47.9/707.2	4	5.5	4.25" dia. borehole, 6' bentonite seal, [5]	
P-8C1	C	--	757.71	NE	01/25/89	79.8/675.3	2	3.8	5.25" dia. borehole, no bentonite seal, [5]	
P-8C2	C	--	757.68	NE	01/27/89	113.0/642.8	2	4.0	4" dia. borehole, no bentonite seal, [5]	
P-8C3	C	--	757.34	NE	01/26/89	133.5/622.1	2	4.5	4.75" dia. borehole, no bentonite seal, [5]	
P-8C4	C	MW-8C4	757.68	NE	01/03/89	180.5/575.3	2	5.4	Schedule 80 PVC, 5.75" dia. borehole, no bentonite seal, [5]	
P-10	A	P-10A	797.05	NW	11/18/88	14.5/779.4	2	2.8	4.25" dia. borehole, 2' bentonite seal, [5]	Drilled through refuse
P-11A	A	--	796.20	NW	11/21/88	13.5/780.6	2	3.2	4.25" dia. borehole, 2' bentonite seal, [5]	
P-12A	A	--	796.90	NW	11/16/89	19.6/774.2	2	3.0	3.25" dia. borehole, 0.5' bentonite seal, [5]	Drilled through refuse
P-13A	A	--	799.94	NW	11/17/89	21.6/775.2	4	6.0	3.25" dia. borehole, 1' bentonite seal, screened in refuse.[5]	Drilled through refuse
P-14A	A	--	797.72	NW	11/20/89	21.5/773.2	4	5.5	3.25" dia. borehole, 1' bentonite seal, [5]	Drilled through refuse
P-21A	A	MW-21A	776.50	SE	11/09/88	22.3/752.2	2	2.8	4.25" dia. borehole, 2' bentonite seal, [5]	
P-23A	A	MW-23A	760.15	NE	11/23/88	19.3/738.5	2	3.3	4.25" dia. borehole, 2' bentonite seal, [5]	
P-23C1	C	--	761.08	NE	01/13/89	77.7/680.4	2	5.9	4.75" dia. borehole, no bentonite seal, [5]	
P-23C2	C	--	761.15	NE	01/12/89	116.1/642.0	2	3.7	4.75" dia. borehole, no bentonite seal, [5]	
P-23C3	C	--	760.83	NE	01/12/89	136.5/621.1	2	3.9	4.75" dia. borehole, no bentonite seal, [5]	
P-23C4	C	--	760.03	NE	01/18/89	177.7/580.5	2	4.5	Schedule 80 PVC, 5.75" dia. borehole, no bentonite seal, [5]	Two points identified on 4/15/91 site map
P-24A	A	MW-24A	788.29	SW	12/04/88	28.8/757.5	2	2.7	4.25" dia. borehole, 2' bentonite seal, [5]	
P-24C1	C	--	788.32	SW	01/19/89	89.9/696.2	2	4.4	4.75" dia. borehole, no bentonite seal, [5]	
P-24C2	C	--	787.90	SW	01/18/89	104.9/681.2	2	3.2	4.75" dia. borehole, no bentonite seal, [5]	
P-24C3	C	--	788.51	SW	01/17/89	119.1/666.9	2	4.5	4.75" dia. borehole, no bentonite seal, [5]	
P-24C4	C	--	788.43	SW	01/16/89	131.2/654.9	2	4.4	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, [5]	

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Piezometer/ Well ID	*Stratigraphic Unit(s) Screened*	*Former/ Other ID* [2]	*Casing Elevation (feet amsl)*	*Site Quadrant* [3]	*Date of Installation*	*Well Depth (feet bgs)/ Bottom Elevation (feet amsl)*	*Screen Length (feet)*	*Sand Pack Length (feet)*	*Well Construction Details* [4]	*Comments*
P-25A	A	MW-25A	793.83	SE	12/06/88	32.2/759.9	2	3.0	4.25" dia. borehole, 2.3' bentonite seal, [5]	
P-25C2	C	--	794.86	SE	01/20/89	122.0/670.4	2	4.0	4.75" dia. borehole, no bentonite seal, [5]	
P-26A	A	--	792.32	NW	11/21/89	13.9/775.3	3.5	3.7	3.25" dia. borehole, 0.5' bentonite seal, [5]	
P-27A	A	MW-27A	780.32	SE	12/01/88	17.0/761.6	2	3.5	4.25" dia. borehole, 2' bentonite seal, [5]	
P-27C1	C	--	780.42	SE	01/13/89	79.3/699.8	2	4.0	4.75" dia. borehole, no bentonite seal, [5]	
P-27C2	C	--	780.10	SE	01/10/89	109.3/669.4	2	5.0	4" dia. borehole, no bentonite seal, [5]	
P-27C3	C	--	780.10	SE	01/12/89	130.3/648.4	2	6.0	4.25" dia. borehole, no bentonite seal, [5]	
P-27C4	C	--	781.96	SE	01/17/89	18.7/599.5	2	4.5	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, [5]	
P-28A	A	MW-28A	775.37	NE	11/28/88	26.1/748.2	2	3.0	4.25" dia. borehole, 2' bentonite seal, [5]	
P-28C1	CB	--	777.05	NE	01/16/89	85.0/689.4	2	3.2	4.25" dia. borehole, no bentonite seal, [5]	
P-28C2	C	--	776.35	NE	01/26/89	121.9/652.2	2	4.5	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, [5]	
P-28C3	C	--	776.79	NE	01/26/89	135.1/639.1	2	6.0	4.75" dia. borehole, no bentonite seal, [5]	
P-28C4	C	--	776.50	NE	01/25/89	201.8/572.3	2	7.0	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, [5]	
P-29A	A	MW-29A	773.78	NE	11/30/88	13.5/758.1	2	2.4	4.25" dia. borehole, 4' bentonite seal, [5]	
P-29C2	C	--	772.92	NE	01/18/89	116.2/655.4	2	4.9	4" dia. borehole, no bentonite seal, [5]	
P-30A	A	MW-30A	761.97	NW	11/22/88	20.4/739.6	2	2.9	4.25" dia. borehole, 2.5' bentonite seal, [5]	
P-30C1	C	--	762.56	NW	01/23/89	59.8/700.0	2	4.3	4" dia. borehole, no bentonite seal, [5]	
P-30C2	C	--	764.02	NW	01/31/89	102.4/659.2	2	4.5	4.75" dia. borehole, no bentonite seal, [5]	
P-30C3	C	--	764.37	NW	01/30/89	122.4/639.1	2	4.2	4.75" dia. borehole, no bentonite seal, [5]	
P-30C4	C	--	762.87	NW	01/19/89	219.8/541.0	2	10.3	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, (5)	

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Piezometer/ Well ID	*Stratigraphic Unit(s) Screened*	*Former/ Other ID* [2]	*Casing Elevation (feet amsl)*	*Site Quadrant* [3]	*Date of Installation*	*Well Depth (feet bgs)/ Bottom Elevation (feet amsl)*	*Screen Length (feet)*	*Sand Pack Length (feet)*	*Well Construction Details* [4]	*Comments*
P-31A	A	MW-31A	783.02	NW	11/29/88	14.9/765.7	2	2.9	4.25" dia. borehole, 2' bentonite seal, [5]	
P-31C1	C	--	782.78	NW	01/10/89	86.7/694.0	2	2.6	4.75" dia. borehole, no bentonite seal, [5]	
P-31C2	C	--	782.60	NW	01/09/89	111.6/669.1	2	2.5	4.75" dia. borehole, no bentonite seal, [5]	
P-31C3	C	--	782.75	NW	01/06/89	134.2/646.5	2	3.5	4" dia. borehole, no bentonite seal, [5]	
P-31C4	C	--	782.77	NW	01/17/89	194.1/586.5	2	3.4	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, [5]	
P-32A	A	--	798.53	NW	11/22/89	18.1/777.7	4.5	5.0	3.25" dia. borehole, 0.3' bentonite seal, [5]	
P-32C2	C	--	797.84	NW	01/13/89	130.8/665.0	2	2.8	4.75" dia. borehole, no bentonite seal, [5]	
P-33A	A	MW-33A	798.06	NW	11/11/88	20.0/775.2	2	3.1	4.25" dia. borehole, 2' bentonite seal, [5]	
P-34A	A	MW-34A	794.73	NW	10/11/88	18.8/772.8	2	2.7	4.25" dia. borehole, 2' bentonite seal, [5]	Drilled through refuse. Removed 11/07/89. Now a sump.
P-34*A	A	MW-34*A	796.01	NW	12/07/88	26.0/767.9	1.3	3.0	4.25" dia. borehole,2' bentonite seal, [5]	
P-34*C1	C	--	796.16	NW	01/10/89	97.7/696.4	2	2.7	4.25" dia. borehole, no bentonite seal, [5]	
P-34*C2	C	--	795.88	NW	01/12/89	126.6/667.3	2	4.0	4.75" dia. borehole, no bentonite seal, [5]	
P-34*C3	C	--	796.27	NW	01/11/89	149.8/644.1	2	3.8	4.75" dia. borehole, no bentonite seal, [5]	
P-34*C4	C	--	796.29	NW	01/11/89	193.7/600.3	2	3.7	Schedule 80 PVC, 4.75" dia. borehole, no bentonite seal, [5]	
MW-1	A/B?	W-1	790.61	NW	12/26/78	42/749	2	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	Buried?
MW-2	A	W-2	769.88	NE	12/26/78	20/750	2	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	Not accessible ?
MW-3	A?	W-3	771.57	NE	12/27/78	38/732	2	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	
MW-4	A	W-4	786.24	SE	02/20/79	19/?	7?	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	Disturbed, casing broken.

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Piezometer/ Well ID	*Stratigraphic Unit(s) Screened*	*Former/ Other ID* [2]	*Casing Elevation (feet amsl)*	*Site Quadrant* [3]	*Date of Installation*	*Well Depth (feet bgs)/ Bottom Elevation (feet amsl)*	*Screen Length (feet)*	*Sand Pack Length (feet)*	*Well Construction Details* [4]	*Comments*
MW-5	B	W-5	789.23	SE	02/20/79	35/740	2	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	
MW-6	A/B?	W-6	780.63	SW	01/03/79	51/724	2	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	Formerly buried. Casing raised ~3.5
MW-7	B?	W-7	776.87	SW	12/29/78	36/737	2	unknown	4" dia. casing, glued joints, 25-slot screen, no bentonite seal or grout	Not accessible. Buried?
MW-8	B/C?	W-8	unknown	NW	unknown	unknown	unknown	unknown	unknown	Former residential well. Buried?
MW-20	A/B?	W-20	767.23	NE	05/19/83	45.5/721.7	15	17.5	4" dia. PVC, 10.5" dia. borehole, 2' bentonite seal	Possible grout contamination.
MW-21S	B	W-21, MW021	778.00	SE	05/27/83	60.0/718.0	15	20.0	4" dia. PVC, 10.5" dia. borehole, 2' bentonite seal	
MW-21M	C	--	777.37	SE	01/27/87	94.8/682.5	10	18.3	4.25" dia. borehole, 11.5' bentonite seal	
MW-21L	C	--	777.01	SE	01/20/87	212.0/565.0	10	14.0	4.25" dia. borehole, 5' bentonite seal	
MW-22	B	--	757.17	NW	06/01/83	38.5/718.7	15	14.5	4" dia. PVC, 10.5" dia. borehole, 2' bentonite seal	
MW-23B	B	MW-23BW	759.84	NE	11/22/88	39.4/718.2	5	7.0	4.5" dia. borehole, 2' bentonite seal	
MW-23S	A/B	--	765.41	NE	04/08/85	48.0/717.4	20	24.0	6.5" dia. borehole	
MW-23M	A/B/C	--	765.46	NE	04/08/85	85.5/680.0	20	69.5	6.5" dia. borehole, 1' bentonite seal	
MW-23L	B/C	MW-23D	765.50	NE	04/08/85	122.0/643.5	20	92.0	6.5" dia. borehole, 1' bentonite seal	
MW-24B	B	P-24B	787.70	SW	12/04/88	74.2/711.9	5	7.0	4.5" dia. borehole, 2' bentonite seal [5]	
MW-24S	C	P-24S	789.66	SW	12/05/86	75.0/714.7	10	19.0	7.25" dia. borehole, 5' bentonite seal	
MW-24M	B/C	P-24M	788.96	SW	01/26/87	108.5/680.5	10	28.5	4.5" dia. borehole, 5' bentonite seal	

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Piezometer/ Well ID	*Stratigraphic Unit(s) Screened*	*Former/ Other ID* [2]	*Casing Elevation (feet amsl)*	*Site Quadrant* [3]	*Date of Installation*	*Well Depth (feet bgs)/ Bottom Elevation (feet amsl)*	*Screen Length (feet)*	*Sand Pack Length (feet)*	*Well Construction Details* [4]	*Comments*
MW-24L	C/D	MW-24L1, P-24L	788.86	SW	01/22/87	142.8/646.0	10	22.8	4.5" dia. borehole, 5' bentonite seal	Abandoned, not plugged. High pH-grout? Replaced.
MW-24L2	C	MW-24L1, P-24L2	788.65	SW	1/87, 5/87	136.0/652.6	10	36.0	Schedule 80 PVC, 4.5" dia. borehole, 56' bentonite seal	
MW-25	A/B	OW-25	789.96	SE	12/17/86	74.0/716.0	10	38.0	7.25" dia. borehole, 5' bentonite seal	Possible grout contamination.
MW-25B	B/C?	MW-25BW,	793.81	SE	12/07/88	78.5/713.7	5	6.5	4.5" dia. borehole, 2' bentonite seal, [5]	
MW-26	B	OW-26	791.40	NW	01/06/87	77.2/14.2	10	16.7	4.5" dia. borehole, 5.5' bentonite seal [5]	
MW-27B	B	MW-27BW	779.76	SE	12/01/88	55.0/723.2	5	7.0	4.25" dia. borehole, 2.5' bentonite seal, [5]	
MW-27S	B/C	--	778.95	SE	04/29/87	72.0/707.0	10	34.0	4.5" dia. borehole, 9.3' bentonite seal, [5]	
MW-27M	B/C	--	779.44	SE	04/29/87	101.4/678.0	5	48.4	4.5" dia. borehole, 10' bentonite seal, [5]	
MW-28B	B	MW-28BW	775.64	NE	11/28/88	60.0/713.7	10	6.8	4.25" dia. borehole, 2' bentonite seal, [5]	
MW-28S	A/B	--	775.71	NE	05/04/87	60.5/715.2	5	17.5	4.5" dia. borehole, 10' bentonite seal, [5]	
MW-28M	B/C	--	776.20	NE	05/01/87	101.1/675.2	10	28.0	4.5" dia. borehole, 5' bentonite seal, [5]	
MW-29B	B	MW-29BW	773.43	NE	11/30/88	51.9/719.3	10	7.4	4.25" dia. borehole, 9.8' bentonite seal, [5]	
MW-30B	B	MW-30BW	462.02	NW	11/21/88	42.2/718.8	5	8.2	4.25" dia. borehole, 4' bentonite seal, [5]	
MW-31B	B	MW-31BW	782.99	NW	11/29/88	61.9/719.0	5	6.9	4.5" dia. borehole, 3' bentonite seal, [5]	
MW-32B	B	P-32B,	798.89	NW	11/14/88	78.0/718.4	5	8.0	4.5" dia. borehole, 2' bentonite seal, [5]	
MW-33B	B	MW-33BW	796.57	NW	11/10/88	725./722.2	5	8.5	4.25" dia. borehole, 12' bentonite seal, [5]	
MW-34*B	B	MW-34B	796.15	NW	12/06/88	74.9/719.2	4.2	6.2	4.25" dia. borehole, 2' bentonite seal, [5]	
6" Diameter Supply Well	B/C?	unknown	796.78	NW	unknown	unknown	unknown	unknown	unknown	
Former Support Facilities (Trailer Well)	unknown	unknown	unknown	SE	unknown	unknown	unknown	unknown	unknown	

TABLE 7.1

SUMMARY OF MONITORING WELL AND PIEZOMETER DATA[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

[1] This monitoring well and piezometer summary was derived from data tables and well construction logs included in the following sources:

- Site Map (4/15/91) obtained from Geosciences Research Associates, Inc.;
- "CAP Task I - Description of Current Conditions", Geosciences Research Associates, Inc. (12/7/89);
- Memorandum Report, Geosciences Research Associates, Inc. (4/28/89); and
- "Hazardous Waste Groundwater Task Force Evaluation of the Four County Landfill, Fulton County, IN", USEPA, May 1987.

[2] Stratigraphic units are defined as follows:

A = Glacial till sequence, silty clay loam with silt and sand seams;
B = Glacio-lacustrine sequence, silt to fine- to medium-grained sand;
C = Glacio fluvial sequence, poorly sorted silt, sand, and gravel; and
D = Basal till, silty clay with reddish hue at base.

[3] Site quadrants are arbitrarily defined by the 7+00 North and 8+00 East survey grid lines.

[4] Well materials are assumed to be 2-inch diameter, threaded, Schedule 40 PVC with a 10-slot screen, unless otherwise noted.

[5] Well annulus filled with Volclay grout from filter pack or annular seal to surface.

[6] Well annulus filled with pea gravel and bentonite grout from filter pack or annular seal to surface.

Key:

amsl = Above mean sea level
bgs = Below ground surface
dia. = Diameter
unknown = Information incomplete or unavailable
-- = Not applicable

TABLE 7.2

GROUNDWATER MONITORING WELLS AND
PIEZOMETERS TO BE ABANDONED
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Northwest Quadrant	*Northeast Quadrant*
MW-1	MW-2
MW-8	MW-3
	MW-20
	MW-23S
	MW-23M
	MW-23L
	MW-28S
	MW-28M
Total = 2	Total = 8

Southwest Quadrant	*Southeast Quadrant*
MW-6	MW-4
MW-7	MW-5
MW-24M	MW-25
P-2	MW-27S
	MW-27M
	P-4C4
Total = 4	Total = 6

Total - All Quadrants = 20

TABLE 7.3

RATIONALE FOR ABANDONMENT OF MONITORING WELLS AND PIEZOMETERS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well/Piezometer ID#	*Quadrant Location*	*Well Depth (ft)*	*Abandonment Rationale*
MW-1	NW	42	Improper construction specifications [1]
MW-8	NW	unknown	Construction details unknown. Former residential well. Buried.
MW-2	NE	20	Improper construction specifications
MW-3	NE	38	Improper construction specifications
MW-23S	NE	48	Excessively long effective screened interval [2]
MW-23M	NE	85.5	Excessively long effective screen length
MW-23L	NE	122	Excessively long effective screen length
MW-28S	NE	60.5	Excessively long effective screen length
MW-28M	NE	101.1	Excessively long effective screen length
MW-20	NE	45.5	Stratigraphic units monitored not defined. Possible grout contamination. Excessively long effective screen interval.
MW-6	SW	51	Improper construction specifications
MW-7	SW	36	Improper construction specifications
MW-24M	SW	108.5	Excessively long effective screen length
P-2	SW	80	Improper construction specifications

TABLE 7.3

RATIONALE FOR ABANDONMENT OF MONITORING WELLS AND PIEZOMETERS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well/Piezometer ID#	*Quadrant Location*	*Well Depth (ft)*	*Abandonment Rationale*
MW-4	SE	19	Improper construction specifications
MW-5	SE	35	Improper construction specifications
MW-25	SE	74	Excessively long effective screen length
MW-27S	SE	72	Excessively long effective screen length
MW-27M	SE	101.4	Excessively long effective screen length
P-4C4	SE	152.5	Redundancy, monitors same stratigraphic horizon as adjacent P-4C3

[1] Improper construction specifications include one or more of the following:
- glued PVC joints which may contribute organic contaminants to the sample or formation
- no bentonite pellet seal or annular space sealant
- hand slotted well screen

[2] Effective screened interval includes the length of the screened interval and the filter pack which may facilitate connection between separate hydrostratigraphic units.

TABLE 7.4

GROUNDWATER MONITORING WELL NETWORK[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Northwest Quadrant

Monitoring Wells = 6
Piezometers = 18

MW-26	P-33A
MW-30B	P-30A
MW-31B	P-30C1
MW-32B	P-30C2
MW-33B	P-32A
MW-34*B [2]	P-32C2
P-10	P-31A
P-11A	P-31C1
P-12A	P-31C2
P-13A	P-34*A
P-14A	P-34*C1
P-26A	P-34*C2

Northeast Quadrant

Monitoring Wells = 3
Piezometers = 13

MW-23B	P-23C2
MW-28B	P-28A
MW-29B	P-28C1
P-7B	P-28C2
P-29A	
P-29C2	
P-8A	
P-8B	
P-8C1	
P-8C2	
P-23A	
P-23C1	

Southwest Quadrant

Monitoring Wells = 1
Piezometers = 14

MW-24B	P-5C1
P-1A	P-5C2
P-1	P-24A
P-3	P-24C1
P-6A	P-24C2
P-2A	
P-2B	
P-2C2	
P-5A	
P-5B	

Southeast Quadrant

Monitoring Wells = 5
Piezometers = 11

MW-21L	P-4B
MW-21S	P-4C1
MW-21M	P-4C2
MW-25B	P-27A
MW-27B	P-27C1
P-3A	P-27C2
P-21A	
P-25A	
P-25C2	
P-4A	

TOTALS:	
Piezometers	56
Monitoring Wells	15
	71

[1] All wells known to have been installed are listed, although some may have been damaged or abandoned.
[2] A piezometer/monitoring well cluster with a numeric designation of "34*" was installed by Geosciences Research Associates between December 1988 and January 1989. The asterisk (*) is not a footnote, but rather a means of distinguishing this cluster from P-34A, also located in the northwest quadrant.

TABLE 7.5

RESPONSE TEST LOCATIONS
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Monitoring Well/ Piezometer ID#	*Quadrant Location*	*Screened Interval (ft amsl)* [1]	*Stratigraphic Unit*
P-29C2	NE	657.4 to 655.4	C
MW-29B	NE	729.3 to 719.3	B
MW-31B	NW	724.0 to 719.0	B
P-34*C3	NW	602.3 to 600.3	C
P-27C2	SE	671.4 to 669.4	C
P-4B	SE	720.6 to 718.6	B
P-5C4	SW	610.3 to 608.3	C
MW-24B	SW	716.9 to 711.9	B

[1] Screened interval measured in feet above mean sea level (ft amsl) datum.

Key: amsl = Above mean sea level